FORTY-FOURTH ANNUAL REPORT

OF THE

SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

OF THE

STATE OF MICHIGAN

AND

EIGHTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

FROM

JULY 1, 1904, TO JUNE 30, 1905

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1905

REPORT OF THE SECRETARY

OF THE

STATE BOARD OF AGRICULTURE

AGRICULTURAL COLLEGE, *July 1, 1905.*

TO HONORABLE FRED M. WARNER,

Governor of the State of Michigan:

SIR—I have the honor to submit to you herewith, as required by law, the accompanying report for the fiscal year ending June 30, 1905, with supplementary papers.

Very respectfully,

ADDISON M. BROWN,

Secretary of the State Board of Agriculture.

STATE BOARD OF AGRICULTURE

		Term Expires
CHARLES J. MONROE, South Haven,	- - - - - - -	1907
PRESIDENT OF THE BOARD.		
HENRY F. BUSKIRK, Wayland,	- - - - - - -	1907
WILLIAM H. WALLACE, Bayport,	- - - - - -	1909
AARON P. BLISS, Saginaw	- - - - - - -	1909
ROBERT D. GRAHAM, Grand Rapids,	- - - - - -	1911
THOMAS F. MARSTON, Bay City,	- - - - - -	1911
FRED M. WARNER, GOVERNOR OF THE STATE,	- - -	*Ex-Officio.*
JONATHAN L. SNYDER, PRESIDENT OF THE COLLEGE,	-	*Ex-Officio.*

A. M. BROWN, Agricultural College, Secretary.
B. F. DAVIS, Lansing, Treasurer.

STANDING COMMITTEES.

The President of the Board is *ex-officio* a member of each of the Standing Committees.

BOTANY AND HORTICULTURE, -	R. D. Graham, H. F. Buskirk.
BUILDINGS AND COLLEGE PROPERTY, -	A. P. Bliss, W. H. Wallace.
CHEMICAL, PHYSICAL, BACTERIOLOGICAL AND OTHER DEPARTMENTS NOT OTHERWISE PROVIDED FOR - -	A. P. Bliss, T. F. Marston.
EMPLOYEES, - - - - - -	R. D. Graham, H. F. Buskirk, J. L. Snyder.
ENGLISH AND MATHEMATICS, - -	W. H. Wallace, T. F. Marston.
EXPERIMENT STATION, - - -	H. F. Buskirk, A. P. Bliss.
FARM MANAGEMENT, - - - -	T. F. Marston, R. D. Graham.
FINANCE, - - - - - -	R. D. Graham, A. P. Bliss.
FORESTRY, - - - - - -	A. P. Bliss, H. F. Buskirk.
FARMERS' INSTITUTES, - - -	T. F. Marston, R. D. Graham.
LAND GRANT, - - - - -	H. F. Buskirk, W. H. Wallace.
LIBRARY, - - - - -	W. H. Wallace, A. P. Bliss.
MECHANICAL DEPARTMENT, - -	W. H. Wallace, R. D. Graham.
MILITARY AND ATHLETIC, - - -	T. F. Marston, W. H. Wallace.
WOMEN'S DEPARTMENT, - - -	H. F. Buskirk, T. F. Marston.

STATE AGRICULTURAL COLLEGE

(Under control of the State Board of Agriculture.)

FACULTY AND OTHER OFFICERS.

JONATHAN L. SNYDER, A. M., Ph. D., President; [a b c] Feb. 25, '96.
WM. J. BEAL, A. M., M. S., Ph. D., Professor of Botany and Curator of the Botanical Museum; [a b] July 9, '70; [c] Sept. 1, '02.
FRANK S. KEDZIE, M. S., Professor of Chemistry; [a] Sept. 15, '80; [b c] Sept. 1, '02.
WILLIAM S. HOLDSWORTH, M. S., Professor of Drawing; [a] Feb. 22, '81; [b] Aug. 22, '87; [c] Sept. 1, '03.
LEVI R. TAFT, M. S., Superintendent of Farmers' Institutes and State Inspector of Orchards and Nurseries; [a] Aug. 1, '88; [b c] July 1, '02.
HOWARD EDWARDS, A. M., LL. D., Professor of English Literature and Modern Languages; [a b c] Aug. 25, '90.
HERMAN K. VEDDER, C. E., Professor of Mathematics and Civil Engineering; [a b c] Sept. 15, '91.
CLINTON D. SMITH, M. S., Dean of Short Courses, College Extension Lecturer; [a b] Sept. 1, '93; [c] July 1, '02.
CHARLES L. WEIL, B. S., Professor of Mechanical Engineering and Director of the Mechanical Department; [a b c] Sept. 1, '93.
WALTER B. BARROWS, B. S., Professor of Zoology and Physiology and Curator of the General Museum; [a b c] Feb. 15, '94.
GEORGE A. WATERMAN, B. S., M. D. C., Professor of Veterinary Science; [a b c] Sept. 1, '98.
CHARLES E. MARSHALL, Ph. D., Professor of Bacteriology and Hygiene; [a] Sept. 1, '98; [b c] Sept. 1, '02.
ULYSSES P. HEDRICK, M. S., Professor of Horticulture and Landscape Gardening and Superintendent of Grounds; [a] Sept. 1, '99; [b c] July 1, '02.
JOSEPH A. JEFFERY, B. S. A., Professor of Agronomy and Soil Physics; [a] Sept. 1, '99; [b c] Nov. 11, '02.
MAUD GILCHRIST, B. S., Dean of the Women's Department; [a b c] Sept. 1, '01.
ADDISON M. BROWN, A. B., Secretary; [a b c] June 1, '02.
ROBERT S. SHAW, B. S. A., Professor of Agriculture and Superintendent of Farm; [a b c] Sept. 1, '02.
ERNEST E. BOGUE, M. S., A. M., Professor of Forestry; [a b c] Sept. 1, '02.
MAJOR WILLIAM H. KELL, U. S. A., Professor of Military Science and Tactics; [a b c] Feb. 24, '04.

ARTHUR R. SAWYER, E. E., Professor of Physics and Electrical Engineering; [a b c] April 11, '04.

WILBUR O. HEDRICK, M. S., Assistant Professor of History and Political Economy; [a b] Aug. 24, '91; [c] Sept. 1, '93.

WARREN BABCOCK, B. S., Assistant Professor of Mathematics; [a b] June 30, '91; [c] Sept. 1, '93.

E. SYLVESTER KING, Assistant Professor of English; [a] Jan. 1, '00; [b c] Sept. 1, '02.

*HERMAN W. REYNOLDS, B. S. in M. E., Assistant Professor of Mechanical Engineering; [a] Sept. 1, '00; [b c] Sept. 1, '02.

JAMES B. DANDENO, A. M., Ph. D., Assistant Professor of Botany; [a b c] Sept. 1, '02.

The names of instructors whose resignations took effect between June 30 and Sept. 1, '04, do not appear below.

THOMAS GUNSON, Instructor in Floriculture and Foreman of Greenhouse; [a b] April 1, '91; [c] March 1, '01.

MRS. LINDA E. LANDON, Librarian; [a b c] Aug. 24, '91.

W. S. LEONARD, Instructor in Mechanical Engineering; [a b c] Sept. 1, '96.

RUFUS H. PETTIT, B. S. A., Instructor in Zoology; [a b c] Jan. 1, '97.

MRS. JENNIE L. K. HANER, Instructor in Domestic Art; [a b c] Sept. 1, '97.

CHACE NEWMAN, Instructor in Mechanical Drawing; [a b] Sept. 1, '97; [c] July 23, '01.

E. C. BAKER, Foreman of Foundry; [a b c] Nov. 1, '97.

CAROLINE L. HOLT, Instructor in Drawing; [a b c] Sept. 1, '98.

BERTHA M. WELLMAN, B. S., B. Pd., Instructor in English; [a b c] Sept. 1, '00.

SARAH B. S. AVERY, Instructor in Physical Culture; [a b c] Sept. 1, '00.

JESSE J. MYERS, B. S., Instructor in Zoology; [a b c] Sept. 1, '01.

**JENNETTE C. CARPENTER, B. S., Instructor in Domestic Science; [a] Sept. 1, '02; [b c] Sept. 1, '04.

LOUISE FREYHOFER, B. S., Instructor in Music; [a b c] Sept. 1, '02.

L. W. SAWTELLE, B. S., Ph. B., Instructor in English; [a b c] Sept. 1, '02.

L. G. HOLBROOK, Ph. B., Instructor in Physics; [a b c] Sept. 1, '02.

HARRY S. REED, Instructor in Chemistry; [a b c] Sept. 1, '02.

ANDREW KRENTEL, Foreman Wood Shop; [a b c] Sept. 1, '02.

H. W. NORTON, JR., B. S., Instructor in Animal Husbandry; [a b c] Sept. 1, '03.

RICHARD HOPKINS, B. S. in C. E., Instructor in Civil Engineering; [a b c] Sept. 1, '03.

GEORGE W. HARTWELL, Ph. B., Instructor in Mathematics; [a b c] Sept. 1, '03.

WARD R. SHEDD, B. S. Instructor in Mechanical Engineering; [a b c] Sept. 1, '03.

HARVEY L. CURTIS, A. M., Instructor in Physics; [a b c] Sept. 1, '03.

HELEN E. ST. JOHN, Instructor in Sewing; [a b c] Sept. 1, '03.

CHESTER L. BREWER, B. S., Director of Physical Culture; [a b c] Sept. 1, '03.

ALBERT E. JONES, A. B., Instructor in Mathematics; [a b c] Sept. 15, '03.

C. A. MCCUE, B. S., Instructor in Horticulture; [a b c] Oct. 1, '03.

LESLIE B. MCWETHY, B. S., Instructor in Agriculture; [a b c] June 1, '04.

ALBERT G. CRAIG, B. S., Instructor in Horticulture; [a b c] Sept. 1, '04.

ARTHUR PETERS, Instructor in Physics; [a b c] Sept. 1, '04.

CARL GUNDERSEN, A. M., Ph. D., Instructor in Mathematics; [abc] Sept. 1, '04.
WALTER G. SACKETT, B. S., Instructor in Bacteriology and Hygiene; [abc] Sept. 1, '04.
W. W. WELLS, B. S., Instructor in Mechanical Engineering; [abc] Sept. 1, '04.
WILLIAM F. LAMOREAUX, Instructor in Chemistry; [abc] Sept. 1, '04.
EDWARD BOYER, Instructor in Chemistry; [abc] Sept. 1, '04.
†GEORGE R. SWEET, M. S., Instructor in Mathematics; [abc] Sept. 1, '04.
ELLEN B. BACH, M. S., Instructor in Botany; [abc] Sept. 1, '04.
ARTHUR E. PALMER, Instructor in Mechanical Drawing; [abc] Sept. 1, '04.
CHARLES S. WILLIAMSON, M. S., Instructor in Chemistry; [abc] Sept. 1, '04.
FLOYD E. MILLS, B. S., Instructor in Civil Engineering; [abc] Sept. 1, '04.
VIRGILIA PURMORT, Instructor in Cookery; [abc] Sept. 1, '04.
CHARLES H. SWANGER, B. S., Instructor in Chemistry; [abc] Sept. 1, '04.
OTIS N. BLAIR, B. S., Instructor in Mechanical Engineering; [abc] Sept. 1, '04.
FLOYD O. FOSTER, B. S., Instructor in Dairying; [abc] Sept. 1, '04.
LEWIS F. BIRD, B. S., Assistant Experimenter in Live Stock; [abc] Sept. 1, '04.
MRS. MINNIE A. W. HENDRICK, A. B., Instructor in History and Economics; [abc] Sept. 1, '04.
MARY WETMORE, M. D., Assistant in Bacteriology; [abc] Sept. 1, '04.
L. T. CLARK, B. S., Assistant in Bacteriology; [abc] Sept. 1, '04.
W. R. WRIGHT, B. S., Assistant in Bacteriology; [abc] Sept. 1, '04.
ARCHIE R. ALGER, B. S., Instructor in Mathematics; [abc] Nov. 15, '04.
FRED C. KENNEY, Cashier; [ab] Sept. 18, '95; [c] Oct. 1, '97.
‡LENA M. MAXWELL, Bookkeeper; [abc] July 1, '02.
S. ALICE EARL, Clerk to Secretary; [abc] Oct. 1, '02.
COWAN H. MCGUGAN, Bookkeeper, [abc] June 1, '05.
ELIDA YAKELEY, Secretary to President; [abc] July 15, '03.
B. A. FAUNCE, Clerk to President and Editor M. A. C. Record; [abc] Sept. 1, '04.
L. F. NEWELL, Engineer; [abc] Jan. 1, '98.
E. A. BOWD, Architect; [abc] Jan. 1, '02.
ROWENA KETCHUM, in charge of College Hospital; [abc] Sept. 1, '00.
CAROLINE BALBACH, Assistant Librarian; [abc] Jan. 1, '04.

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a First appointment.
b Present appointment.
c Present title.
* Resigned, Sept. 1, '04.
** Resigned, May 1, '05.
† Resigned, Nov. 20, '04.
‡ Resigned, June 15, '05.

AGRICULTURAL EXPERIMENT STATION

OF THE

MICHIGAN AGRICULTURAL COLLEGE

(Under the control of the State Board of Agriculture.)

STATION COUNCIL.

J. L. SNYDER, M. A., Ph. D., Pres., *Ex-officio* Member.
CLINTON D. SMITH, M. S., Director.
L. R. TAFT, M. S., - Horticulturist.
R. H. PETTIT, B. S. A., Entomologist.
*F. W. ROBISON, B. S., - Chemist.
A. J. PATTEN, B. S., - Chemist.
CHAS. E. MARSHALL, Ph. D., Bacteriologist and Hygienist.
R. S. SHAW, B. S. A., Experimenter with Live Stock.
A. M. BROWN, A. B., - Sec. and Treas.

ADVISORY AND ASSISTANT STAFF.

F. S. KEDZIE, M. S., Associate Chemist.
GEO. A. WATERMAN, V. S., M. D. C., Consulting Veterinarian.
MRS. L. E. LANDON, - Librarian.
W. G. SACKETT, B. S., Asst. in Bacteriology and Hygiene.
W. R. WRIGHT, B. S., Asst. in Bacteriology and Hygiene.
T. A. FARRAND, - In Charge of South Haven Sub-Station.
LEO. M. GEISMAR Chatham, In Charge of Upper Peninsula Experiment Station.

SUB-STATIONS.

Grayling, Crawford County, 80 acres deeded.
South Haven, Van Buren County, 10 acres rented; 5 acres deeded. Local agent, T. A. Farrand.
Chatham, Alger County, 160 acres deeded. Local agent, Leo M. Geismar.

STANDING COMMITTEE IN CHARGE.

HON. H. F. BUSKIRK, - - - - - - - - - - - - Wayland.
HON. A. P. BLISS, - - - - - - - - - - - Saginaw.

STATE WEATHER SERVICE

(Under the control of the State Board of Agriculuture.)

C. F. SCHNEIDER, Director U. S. Weather Bureau. - - - - Grand Rapids.

*Resigned April 1, 1905.

ACCOUNTS OF THE STATE AGRICULTURAL COLLEGE

FOR THE YEAR ENDING JUNE 30, 1905

SECRETARY'S FINANCIAL REPORT.

			Dr.	Cr.
July 1, 1904.	To cash on hand		$1,163 00	
July 1, 1904.	To cash on deposit, college treasurer		7,165 96	
June 30, 1905.	To special appropriation receipts		112,821 79	
	From State Treasurer	$92,300 00		
	From United States Treasurer	15,000 00		
	From institution and other sources	5,521 79		
June 30, 1905.	By special appropriation disbursements			$108,436 60
June 30, 1905.	To current account receipts		211,180 61	
	From State Treasurer, land grant interest	$72,035 32		
	From State Treasurer, one-tenth mill tax	64,000 00		
	From United States Treasurer	25,000 00		
	From institution and other sources	49,197 00		
	From South Haven Experiment Station	624 91		
	From Upper Peninsula Experiment Station	216 40		
	From Farmers' Institutes	106 98		
	By general account disbursements			201,382 93
	From current account	$185,577 56		
	From supplementary accounts	15,805 37		
	By cash on deposit, college treasurer			20,517 18
	By cash on hand			1,994 65
			$332,331 36	$332,331 36

TABLE No. 1.—*Tabular exhibit of secretary's report.*

	Balance sheet, July 1, 1904.		Transactions, July 1, 1904, to June 30, 1905.		Balance sheet, June 30, 1905.	
	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Cash	$1,163 00			$831 65	$1,994 65	
College treasurer*	7,165 96			13,351 22	20,517 18	
Special appropriat'ns		$5,418 26	$112,821 79	108,436 60		$9,803 45
Current accounts		2,910 70	210,207 61	185,577 56		12,708 38
Supplementary acc'ts			973 00	15,805 37		
Totals	$8,328 96	$8,328 96	$324,002 40	$324,002 40	$22,511 83	$22,511 83

*Treasurer's statement is greater July 1, 1904 by $13,143.03 and June 30, 1905, by $9,357.57 warrants outstanding.

TREASURER'S ACCOUNT.

Balance on hand July 1, 1904	$20,308 99	
Receipts from State Treasurer and secretary	322,825 44	
Interest on deposits, 12 months at 2½ per cent	345 85	
Warrants paid July 1, 1903, to June 30, 1905		$313,605 53
Balance on hand June 30, 1905		29,874 75
Total	$343,480 28	$343,480 28

TABLE NO. 2.—*Statement of special appropriation account for fiscal year, July 1, 1904, to June 30, 1905.*

Name of appropriation.	Balance of accounts, July 1, 1904.		Receipts during fiscal year.		Total available.	Total expended.	Balance of accounts, June 30, 1905.	
	Dr.	Cr.	From State treasury.	From institution and other sources.			Dr.	Cr.
Experiment Station	....	$1,448 16	*$15,000 00	$4,497 31	$20,945 47	$20,024 52	....	$920 95
Nursery License and Inspection	....	....	....	937 90	937 90	932 90	....	5 00
Sundry Improvements	....	2,711 71	6,300 00	56 40	9,068 11	8,573 05	....	495 06
Power Plant	....	667 71	....	2 00	669 71	41 58	....	628 13
Tunnels	$3,802 73	....	38,000 00	....	34,197 27	34,197 27	....	....
Power House	....	4,405 41	38,000 00	25 86	42,431 27	37,513 72	....	4,917 55
Extension Tunnels	....	....	9,000 00	....	9,000 00	5,529 23	....	3,470 77
Coal Shed	....	....	....	....	....	661 45	$661 45	....
Weather Service	12 00	....	1,000 00	2 32	990 32	962 88	....	27 44
Balance	5,418 26	....	....	....	....	....	9,803 45	....
Total	$9,232 99	$9,232 99	$107,300 00	$5,521 79	$118,240 05	$108,436 60	$10,464 90	$10,464 90

* From U. S. Treasury.

TABLE No. 3.—*Current account, July 1, 1904, to June 30, 1905.*

On account of—	Dr. To disbursements.	Cr. By receipts.
U. S. Treasurer, fifteenth annual payment under act of congress of August 30, 1890	....	$25,000 00
State Treasurer, one-tenth mill tax	....	64,000 00
State treasurer, interest on proceeds of sales of U. S. land grant	....	72,035 32
Salaries	$76,711 01	835 90
Farm department	13,456 12	6,142 72
Horticultural department	6,990 07	3,739 49
Mechanical department	6,638 81	2,236 80
Heating department	17,447 18	278 08
Cleaning department	1,972 31	188 58
Electric lighting department	5,846 12	3,196 05
Office	1,955 66	95 94
Advertising	2,259 54	....
M. A. C. Record	1,051 84	498 45
Special courses	3,247 52	1,534 17
Academic departments	20,582 77	5,487 90
Contingent building	21,163 19	21,718 56
Miscellaneous	3,368 82	2,021 99
Women's	2,886 60	1,197 66
Total	$185,577 56	$210,207 61
Supplementary amounts.		
Bulletins	2,338 91	24 71
Farmers' institutes	7,029 76	106 98
South Haven experiment station	2,585 59	624 91
Upper Peninsula Experiment Station	3,851 11	216 40
Balance at beginning of period, July 1, 1904	....	2,910 70
Balance at close of period, June 30, 1905	12,708 38	....
Total	$214,091 31	$214,091 31

TABLE No. 4.—*Experiment station account, July 1, 1904, to June 30, 1905.*

On account of—	Dr. To disbursements.	Cr. By receipts.
Balance from fiscal year, July 1, 1904	....	$1,448 16
U. S. Treasurer for fiscal year	....	15,000 00
Fertilizer license fees	....	2,430 00
Salaries	$8,232 49	....
Farm department	3,559 97	688 68
Horticultural department	444 95	....
Chemical department	2,239 35	8 80
Botanical department	48 62	....
Entomological department	512 12	....
Library	222 88	....
Sundry	2 75	10 00
Secretary's office	772 89	280 00
Veterinary	111 09	....
Live stock	1,458 36	1,029 83
Bacteriological department	1,772 84	....
Director's office	646 21	....
Balance on hand June 30, 1905, close of fiscal year	920 95	....
Total	$20,945 47	$20,945 47

TABLE No. 5.—*Regular employes and salaries.*

Grade.	Rate per year.	Classification.		Other sources.	
		Current.	Experim't station.		
President's Office.					
President	$5,000 00	$5,000 00	....	....	House.
Clerk	1,000 00	1,000 00	....	....	....
Clerk	600 00	600 00	....	....	....
Agricultural Department.					
Professor	2,400 00	2,000 00	$400 00	....	....
Professor of Agronomy	2,000 00	2,000 00	....	....	....
Inst'r Animal Husbandry	700 00	700 00	....	....	....
Ass't Inst'r Animal Husbandry	700 00	350 00	350 00	....	....
Inst'r Dairying	1,000 00	1,000 00	....	....	....
Inst'r Agriculture	550 00	550 00	....	....	....
Foreman of College Farm	600 00	600 00	....	....	....
Clerk Farm Dept.	480 00	480 00	....	....	....
Bacteriological Dept.					
Professor	2,000 00	1,000 00	1,000 00	....	....
Instructor	1,000 00	850 00	150 00	....	....
Instructor	360 00	360 00	....	....	....
Instructor	200 00	200 00	....	....	....
Instructor	360 00	....	360 00	....	....
Botanical Dept.					
Professor	1,800 00	1,800 00	....	....	House.
Ass't Professor	1,150 00	1,150 00	....	....	....
Instructor	600 00	600 00	....	....	....
Chemical Dept.					
Professor	2,000 00	1,700 00	300 00	....	....
Instructor	900 00	900 00	....	....	....
Instructor	800 00	800 00	....	....	....
Instructor	550 00	550 00	....	....	....
Instructor	550 00	550 00	....	....	....
Instructor	550 00	550 00	....	....	....
Chemist Exp. Station	1,100 00	....	1,100 00	....	Rooms.
Drawing Dept.					
Professor	2,000 00	2,000 00	....	....	....
Inst'r Mechanical Drawing	900 00	900 00	....	....	....
Instructor Drawing	700 00	700 00	....	....	....
Inst'r Mechanical Drawing	550 00	550 00	....	....	....
English Dept.					
Professor	1,800 00	1,800 00	....	....	House.
Ass't Professor	1,000 00	1,000 00	....	....	Rooms
Instructor	800 00	800 00	....	....	....
Instructor	650 00	650 00	....	....	....
Forestry Dept.					
Professor	1,500 00	1,500 00	....	....	....
Horicultural Dept.					
Professor	2,000 00	2,000 00	....	....	....
Instructor	800 00	400 00	400 00	....	....
Instructor	700 00	700 00	....	....	....
Instructor	1,000 00	1,000 00	....	....	House.
Foreman of Grounds	500 00	500 00	....	....	House.
History and Pol. Economy Dept.					
Ass't Professor	1,300 00	1,300 00	....	....	Rooms.
Ass't Instructor	720 00	720 00	....	....	....
Institutes and Nursery Insp'r.					
Superintendent	1,800 00	500 00	600 00	$700 00	House.
Library Dept.					
Librarian	1,000 00	880 00	120 00	....	Rooms.
Ass't Librarian	350 00	350 00	....	....	....
Mathematical Dept.					
Professor	1,800 00	1,800 00	....	....	House.
Ass't Professor	1,250 00	1,250 00	....	....	Rooms.
Inst'r Civil Engineering	800 00	800 00	....	....	....
Inst'r Civil Engineering	750 00	750 00	....	....	....

TABLE No. 5.—*Concluded.*

Grade.	Rate per year.	Classification. Current.	Experim't station.	Other sources.	
Mathematical Dept.—*Con.*					
Inst'r Mathematics	$700 00	$700 00	....	....	....
Inst'r Mathematics	600 00	600 00	....	....	....
Inst'r Mathematics	550 00	550 00	....	....	....
Inst'r Mathematics	550 00	550 00	....	....	....
Mechanical Dept.					
Professor	1,800 00	1,800 00	....	....	House.
Instructor	1,000 00	1,000 00	....	....	....
Instructor	900 00	900 00	....	....	....
Instructor	720 00	720 00	....	....	....
Foreman Machine Shop	1,200 00	1,200 00	....	....	....
Foreman Wood Shop	750 00	750 00	....	....	....
Foreman Foundry	750 00	750 00	....	....	....
Clerk	480 00	480 00	....	....	....
Military Dept.					
Professor	*576 00	576 00	....	....	....
Miscellaneous.					
Dean Short Courses	2,000 00	400 00	$1,600 00	....	House.
Architect	1,500 00	1,500 00	....	....	....
Engineer	1,150 00	1,150 00	....	....	....
Plumber	900 00	900 00	....	....	....
Night Watchman	480 00	480 00	....	....	....
Nurse	450 00	450 00	....	....	....
Dept. of Physics.					
Professor	2,000 00	2,000 00	....	....	....
Instructor	700 00	700 00	....	....	....
Instructor	800 00	800 00	....	....	....
Instructor	600 00	600 00	....	....	....
Dept. of Physical Culture.					
Director	1,300 00	1,300 00	....	....	....
Secretary's Office.					
Secretary	1,800 00	300 00	500 00	$1,000 00	House.
Cashier	1,200 00	1,000 00	200 00	....	....
Bookkeeper	600 00	500 00	100 00	....	....
Clerk	600 00	475 00	125 00	....	....
Clerk	480 00	....	480 00	....	....
Veterinary Dept.					
Professor	1,500 00	1,200 00	300 00	....	....
Women's Dept.					
Dean	1,400 00	1,400 00	....	....	Rooms.
Instructor Sewing	800 00	800 00	....	....	Room.
Instructor Domestic Science	700 00	700 00	....	....	Room.
Instructor Physical Culture	650 00	650 00	....	....	Room.
Instructor Music	850 00	850 00	....	....	....
Instructor Cookery	500 00	500 00	....	....	Room.
Instructor Sewing	400 00	400 00	....	....	Room.
Zoological Dept.					
Professor	1,800 00	1,800 00	....	....	House.
Instructor	1,100 00	500 00	600 00	....	House.
Instructor	800 00	800 00	....	....	....
Total pay roll	$91,256 00	$80,871 00	$8,685 00	$1,700 00	....

* In lieu of quarters.

TABLE No. 6.—*Income of the State Agricultural College from all outside sources from the date of its foundation to the present time.*

Year.	From State Legislature.			From U. S. Congress.			Total.
	For current expenses.	For special purposes.	Land sales, salt spring and swamp land grants.	Morrill act of 1862, interest from land grant and trespass.	Hatch act of 1887, experiment station.	Morrill act of 1890, supplementary endowment.	
1855...			$56,320 00				$56,320 00
1856...							
1857...	$40,000 00						40,000 00
1858...							
1859...	37,500 00						37,500 00
1860...							
1861...	6,500 00		152 25				6,652 25
1862...	10,000 00		218 97				10,218 97
1863...	9,000 00		407 80				9,407 80
1864...	9,000 00		726 09				9,726 09
1865...	15,000 00		1,156 61				16,156 61
1866...	15,000 00		1,094 27				16,094 27
1867...	20,000 00		7,608 38				27,608 38
1868...	20,000 00		592 49				20,592 49
1869...	20,000 00	$30,000 00	17,559 00	$58 96			67,617 96
1870...	20,000 00		1,320 02	2,720 93			24,040 95
1871...	18,250 00	10,500 00	4,135 72	3,785 54			36,671 26
1872...	18,250 00	3,000 00	217 05	7,175 65			28,642 70
1873...	21,796 00	15,602 00	10 13	11,059 06			48,467 19
1874...	13,000 00	15,602 00	150 13	14,061 98			42,814 11
1875...	7,638 00	7,755 50	144 53	14,446 14			29,984 17
1876...	7,638 00	6,755 50	1,773 09	16,830 17			32,996 76
1877...	6,150 00	30,686 80	979 06	15,172 86			52,988 72
1878...	6,150 00	5,686 80	826 60	15,807 09			28,470 49
1879...	4,971 80	16,068 32	712 22	16,978 22			38,730 56
1880...	4,971 80	7,068 32	797 55	17,837 24			30,674 91
1881...	7,249 00	43,720 50	461 95	20,935 25			72,366 70
1882...	7,249 00	8,945 50	358 46	22,507 45			39,060 41
1883...	8,385 00	23,793 00	391 95	30,749 60			63,319 55
1884...	8,385 00	10,526 00	1,259 90	27,909 72			48,080 62
1885...		35,103 00	187 50	29,770 40			65,060 90
1886...		22,617 00		30,461 04			53,078 04
1887...		*44,040 00	198 20	†24,611 37			68,849 57
1888...		30,752 50	144 20	32,406 60	$15,000 00		78,303 30
1889...		*20,973 00	10 50	31,322 69	15,000 00		67,306 19
1890...		*27,172 00	238 50	32,360 64	15,000 00	$15,000 00	89,771 14
1891...		22,947 50	37 38	34,750 54	15,000 00	16,000 00	88,735 42
1892...		22,947 50	137 38	34,948 12	15,000 00	17,000 00	90,033 00
1893...		18,862 50	10 50	37,927 04	15,000 00	18,000 00	89,800 04
1894...		18,862 50	433 59	44,527 26	15,000 00	19,000 00	97,823 35
1895...		‡19,000 00	10 60	45,301 85	15,000 00	20,000 00	99,312 35
1896...		‡16,000 00		43,886 40	15,000 00	21,000 00	95,886 40
1897...		§17,700 00		43,779 54	15,000 00	22,000 00	98,479 54
1898...		‖17,500 00		47,508 28	15,000 00	23,000 00	103,008 28
1899...		¶8,750 00	705 00	52,526 11	15,000 00	24,000 00	100,981 11
1900...		¶72,500 00	175 00	72,298 38	15,000 00	25,000 00	184,973 38
1901††.		¶72,500 00		63,976 79	15,000 00	25,000 00	176,476 79
1902...	100,000 00	**1,000 00		64,081 81	15,000 00	25,000 00	205,081 81
1903...	100,000 00	**1,000 00		65,573 90	15,000 00	25,000 00	206,573 90
1904...	100,000 00	**1,000 00	61 19	67,312 37	15,000 00	25,000 00	208,373 56
1905...	100,000 00	**1,000 00		72,035 32	15,000 00	25,000 00	213,035 32
Totals..	$762,083 60	$727,937 74	$101,723 66	$1,209,402 31	$270,000 00	$345,000 00	$3,416,147 31

*Including appropriation for weather service.
†October 1, 1886, to June 30, 1887, nine months.
‡Including $5,000 for institutes and $1,000 for weather service.
§Including $5,500 for institutes and $1,000 for weather service.
‖Including $5,500 for institutes and $1,000 for weather service.
¶Including $2,750 for institutes and $500 for weather service.
††To June 30. **Weather service.

SUMMARY OF INVENTORY, JUNE 30, 1904.

College farm and park, 671 acres @ $70		$46,970 00
Athletic field and drive, 13 acres @ $87.50		1,137 50
Buildings—		
Library and museum, built 1881	$22,000 00	
College hall, built 1856	17,000 00	
Williams hall, built 1869	30,000 00	
Wells hall, built 1877	20,000 00	
Abbot hall, built 1888, add. in 1896	15,000 00	
Chemical laboratory, built in 1871, south end add. 1881	18,000 00	
Machine shops and foundry, 1885, south end add. 1887	15,000 00	
Veterinary laboratory, built 1885	5,000 00	
Horticultural laboratory, built 1888	7,000 00	
Agricultural laboratory, built 1889, imp. 1897	7,500 00	
Botanical laboratory, built 1892	10,000 00	
Armory, built 1885	6,000 00	
Greenhouses and stable, built 1873, 1879; rebuilt 1892 and 1902	6,000 00	
Boiler house and chimney, built 1893–4	3,000 00	
President's and two frame dwellings, built 1874	12,000 00	
Six brick dwellings, built 1857, 1879 and 1884	18,000 00	
One frame dwelling, built 1885	3,500 00	
Howard terrace dwelling, built 1888	13,000 00	
Farm house dwelling, built 1869	2,000 00	
Herdsman's dwelling, built 1867	400 00	
Seven barns at professors' houses	1,050 00	
Horticultural barn and shed, built 1868, '75, '87	1,200 00	
Cattle barn and shed, built 1862	1,500 00	
Sheep barn, built 1865	1,000 00	
Horse barn, built 1871	1,000 00	
Pig barn, built 1871	1,000 00	
Corn barn, built 1878	400 00	
Grain barn, built 1881	1,600 00	
Horse sheds, built 1894	200 00	
Tool barn, built 1881	1,000 00	
Brickwork shop, built 1857	500 00	
Observatory, built 1880	100 00	
Bath house and fittings, built 1902–3	17,000 00	
Ice house, built 1879	100 00	
Paint shop, built 1879	150 00	
Hospital, built 1894	3,000 00	
Dairy barn, built 1897	800 00	
Waiting room street car terminus, built 1902	1,700 00	
Street car track and fixtures, 600 ft., built 1897	360 00	
Lumber shed, mechanical department	250 00	
Silo	210 00	
Coal shed, built 1899	700 00	
Women's building, built 1900	91,000 00	
Farm barn, built 1900	4,000 00	
Dairy building, built in 1900	15,000 00	
Bacteriological laboratory, built 1902	27,000 00	
		402,220 00
Iron bridge over Cedar river, built 1888		1,500 00
Dynamo at Agricultural laboratory		280 00
Bridge to athletic field		516 50
Amount carried forward		$452,624 00

Amount brought forward		$452,624 00
Heat, light and water department—		
Water works equipment	$6,164 40	
Electric light equipment	7,319 70	
Steam heating plant No. 1	8,457 00	
Steam heating plant No. 2	1,212 50	
Steam heating plant No. 3	698 00	
Steam and water stock	360 06	
Steam and water tools and fixtures	434 45	
		24,646 11
Bacteriological Department—		
Apparatus	$2,852 31	
Chemicals	171 68	
Office fixtures	1,210 45	
Books and pamphlets	56 80	
		4,291 24
Botanical Department—		
Herbarium	$9,461 85	
Museum	803 35	
Books	290 80	
Maps and charts	403 51	
Negatives	220 40	
Photographs and engravings	943 05	
Lantern slides	254 50	
Microscopes and accessories	1,489 28	
Glassware	326 49	
Chemicals, stains, etc	32 22	
Office and class-room equipment	751 95	
Garden tools	73 26	
General equipment	69 29	
Laboratory tools	105 83	
		15,225 78
Chemical department—		
Cases and fixtures	$2,932 37	
Specimens	324 00	
Balances	1,673 25	
Weights	670 20	
Glassware ungraduated	2,740 27	
Glassware graduated	798 00	
Porcelain ware	311 56	
Wooden apparatus	166 95	
Rubber material	70 00	
Platinum ware	1,745 70	
Electrical apparatus	1,178 40	
Hoffman apparatus	140 00	
Miscellaneous apparatus	1,781 25	
Assay room supplies	220 05	
Chemicals, inorganic	718 77	
Chemicals, organic	243 03	
Tools	49 35	
Hardware	652 33	
		16,415 48
Farm Department—		
Live stock, cattle	$8,795 00	
Live stock, swine	851 50	
Live stock, sheep	1,469 00	
Live stock, horses	1,250 00	
Soils laboratory	1,192 06	
Lower class room	184 05	
Tool barn	808 20	
Students' tool room	165 83	
Registered herd barn	77 70	
Horse barn	214 37	
Amount carried forward		$513,202 61

Amount brought forward		$513,202 61
Farm Department—*Continued.*		
Dairy barn	$28 55	
Grain barn	434 33	
Miscellaneous	126 00	
Meat house	112 20	
Farm house	102 93	
Office	732 56	
Office books and library	1,261 85	
Dairy	896 25	
		18,702 38
Horticultural Department—		
Tools	$201 00	
Heavy tools	462 40	
Teams, harness, etc	490 05	
Grafting and pruning tools, etc	20 90	
Carpenter tools	18 85	
Ice tools	38 50	
Animals in Zoo	140 00	
Spraying outfit	426 80	
Aquatic plants	45 00	
Herbarium	145 00	
Class room	543 00	
Seed room	22 50	
Spraying laboratory	66 95	
Large laboratory	338 80	
Office fixtures	766 15	
Greenhouse tools	268 91	
Greenhouse plants	2,232 24	
Miscellaneous	78 90	
		6,305 94
Department of Mathematics and Civil Engineering—		
Surveying instruments	$3,220 16	
Photographic material	59 25	
Tools and apparatus	646 13	
Class rooms	242 50	
Office furniture	411 86	
Engineering class room	192 55	
Astronomical laboratory	838 50	
		5,610 95
Mechanical Department—		
Office and class room fixtures	$2,474 77	
Experimental laboratory instruments	2,228 36	
Experimental laboratory apparatus	3,370 88	
Drawing and mathematical instruments	171 13	
Iron-working machinery	4,975 79	
Small iron-working tools	1,896 85	
Wood-working machinery	1,440 77	
Small wood-working tools	840 53	
Forge shop	677 61	
Foundry	665 41	
Belting, pulleys, shafting, etc	382 44	
Office supplies and stock	644 06	
Sundry supplies	205 67	
Machine shop, stock	1,905 57	
Foundry, stock	344 05	
Wood shop, stock	261 74	
Forge shop, stock	34 73	
		22,520 36
Amount carried forward		$566,342 24

Amount brought forward		$566,342 24
Department of Physics—		
Office and shop	$768 80	
Mechanics	1,011 30	
Heat	468 40	
Sound	185 50	
Light	1,494 95	
Magnetism	65 00	
Dynamic electricity	2,491 30	
Static electricity	1,119 75	
		7,605 00
Women's Department—		
Furniture, musical instruments, etc	$5,041 30	
Cooking school	534 20	
Wood-working room	432 00	
Domestic art	26 27	
Library	102 39	
Offices	330 85	
Miscellaneous	88 25	
Gymnasium	483 77	
		7,039 03
Department of Zoology and Geology—		
General museum	$17,853 75	
Furniture and general apparatus	1,838 10	
Tools	22 10	
Dissecting instruments	360 53	
Office supplies	549 11	
		20,623 59
Carpenter shop		878 43
Drawing Department—Furniture and equipment		2,289 00
English Department—Furniture and equipment		249 75
Forestry Department—Furniture, tools, etc		624 45
Department of History and Economics		174 55
Library		45,564 40
Military Department		679 90
Physical Culture and Athletics		688 05
President's Office		509 88
Secretary's Office		1,869 16
Veterinary Department—Apparatus and equipment		1,688 35
Hospital		231 00
Farmers' Institutes		596 80
Board Rooms		303 75
Post Office		313 00
Weather Bureau		1,893 43
Guest Room		19 75
Cleaning supplies		181 82
Furniture in Chapel		368 10
Paint shop		373 70
Special Courses		476 00
Total		$661,583 13

SUMMARY OF EXPERIMENT STATION INVENTORY.

Lands donated to the Station—		
80 acres at Grayling, fenced and improved at cost	$1,000 00	
5 acres at South Haven, fenced and improved	1,000 00	
160 acres at Chatham, including buildings	4,000 00	
		$6,000 00
Buildings—		
Bacteriological stable	$3,700 00	
Experiment feed barn	800 00	
Veterinary laboratory, experimental rooms	250 00	
House	1,000 00	
Feed mill	100 00	
Station Terrace building	3,000 00	
Seed room	500 00	
Poultry house and yards	625 00	
Storage barn	600 00	
Cold storage fruit house	500 00	
		11,075 00
Bacteriological Department—		
Apparatus	$1,756 60	
Chemicals	406 88	
Office	36 50	
Library	412 75	
		2,612 73
Botanical Department—		
Microscopes	$430 92	
Apparatus	134 68	
Furniture	56 00	
		621 60
Chemical Department—		
Platinum ware	$373 52	
Porcelain ware	65 17	
Chemicals	213 84	
Apparatus	1,012 40	
Glassware	424 69	
		2,089 62
Entomological Department—		
Office equipment	$737 46	
Apparatus	485 30	
Chemicals	44 19	
Books	149 33	
Spraying equipment	59 82	
Miscellaneous	75 68	
		1,551 78
Farm Department—		
Tools and equipment	$1,239 90	
Office	394 45	
		1,634 35
Horticultural Department—		
General apparatus	$457 00	
Office equipment	223 87	
		680 87
Secretary's Office		246 25
Library		3,629 00
South Haven Station, equipment		169 85
Upper Peninsula Station, equipment		396 75
Total		$30,707 80

Note.—No inventory taken for the year ending June 30, 1905.

DEPARTMENT REPORTS.

REPORT OF THE PRESIDENT.

To The Honorable State Board of Agriculture:

Gentlemen—I have the honor to submit herewith, my report as President for the year ending June 30, 1905.

The prosperity of the college during the past few years shows no signs of abating. The enrollment during the year passed the one thousand mark. This is an increase of about one hundred over the preceding year.

The trend of education in this state seems to be strongly toward the type fostered by this institution. This would indicate that the growth of the college in the future would depend very largely upon the liberality of the state in providing teachers and equipment. We have reason to feel grateful for the kind interest and substantial aid given by the state in past years and it is to be hoped that even a more liberal policy may be followed in the future. Why should not those who expect to follow industrial pursuits be given equal opportunities to prepare for their life work with those who expect to follow a profession? If the state will furnish equal opportunities this institution will be required to do a great work in the future.

By the opening of our next school year our new heating and electric lighting system will be ready for use. This system will be very complete and is so designed and constructed as to anticipate the needs of the college for many years. It is not the purpose at this time to give a detailed description of this plant. It is to be hoped, however, that our engineer, Professor Chas. L. Weil, will issue later, a report of this plant accompanied with descriptive plans and illustrations.

An entire new water system was constructed at an expense of about $9,000, also two new wells were added to the two already in use. These wells are about 360 feet deep and furnish the college community with an abundant supply of excellent water.

I regret to record the destruction by fire of Wells Hall. This occurred in the early morning of February 11th. The fire was first discovered in the basement partition between the rooms occupied by the Hesperian Society and a boarding club. The hallways of the west ward were so full of smoke when the fire was discovered that the students living on the third floor were compelled to come down the fire escapes. In a short time, not more than five or six minutes, our volunteer fire department had the hose stretched and was ready for action. Great credit is due to our fire department for prompt and efficient work and had not the partitions been honeycombed from the basement to the roof, their services would have been effective.

Our volunteer fire department consists of twelve young men, six for each line of hose. They drill one hour a day for three days per week. This work is taken in place of military drill and is under the direction and care of Mr. Thomas Gunson.

In our power house a large pump is kept in readiness for fire emergencies and our water system is so arranged as to be readily connected with the river. On this occasion a water pressure of 150 pounds was immediately at the service of the fire department. But in the secret hours of the night the fire had made such headway that with all this equipment at hand, it was impossible to check it. Every precaution was taken to guard against accidents to students and it is a pleasure to record that no one was injured.

A few weeks before this fire, all the students had been given explicit instructions as to the location of the fire escapes. This precaution was well taken as many of them had to feel their way in the dark and smoke through the hallways.

Immediately after the fire, a student relief fund was raised. It was intended at first to distribute this money among students who had lost their clothing and books in the fire. It seemed, however, to be the desire of the students that the money be loaned to them with the expectation that it be returned after they were through college. About $1,100 was contributed to this fund, of which amount $297.25 was contributed by Lansing friends and $490.00 from Book Buying Association, and will be used as a basis for a student loan fund which will be used in aiding worthy students. It is to be hoped that alumni and others who desire to help a worthy cause, will contribute liberally to this fund.

STATE AID.

In addition to our regular appropriation of one hundred thousand annually from the state, the last legislature made the following appropriation:

$9,000 for Northern Peninsula Experiment Station.

$20,000 for experimental work in live stock.

$15,000 for new barn and moving and repairing old ones.

$55,000 for new dormitory.

$115,000 (estimated). This amount is appropriated by the removal for two years of the limit on the one-tenth mill fund and will be used for the erection and equipping of an additional building.

GRADUATING CLASS.

Seventy-five young men and women were graduated on June 21, twenty-three from the Agricultural Course; twenty-four from the Women's Course; twenty-six from the Mechanical Course; one from the Course in Forestry, and one received the Master's Degree in course. In appreciation of the high standing each in his respective field of labor and also of the great service rendered to this institution, the honorary degree of D. Sc. was conferred upon Dr. William James Beal who for thirty-four years has held the chair of botany in this institution, and Professor A. J. Cook of Pasadena College, California, who for twenty-seven years was professor of zoology and entomology in this college.

The Baccalaureate sermon was delivered by the Rev. W. B. Jennings, D. D., pastor of the first Presbyterian Church of Detroit. The commencement address was given by the Honorable Charles E. Townsend, Member of Con-

gress from the 2nd District, this state. The subject of his address was "The Panama Canal." The names and addresses of the graduating class are as follows:

Adams, Ethel Mae, w, Armada.
Anderson, Arthur J., a, Shelby.
Auten, Clyde I., m, Clyde.
Baker, Helen, w, Agricultural College.
Bell, R. Floyd, m, Mason.
Bemis, Bessie E., w, Ionia.
Bennett, Franc C., w, Lansing.
Bennett, Bon C., w, Lansing.
Bennett, Wilmer C., m, Bad Axe.
Benton, Zoe, w, Washington, D. C.
Bolte, John Willard, a, Lakeside, Ill.
Bos, William M., a, Forest Grove.
Brown, Jessie, w, Grand Rapids.
Burk, Oliver W., m, Smith.
Burrell, Orange B., a, South Haven.
Bushnell, Leland D., a, Bronson.
Butterfield, Mary A., w, Detroit.
Campbell, Clara S., w, Lansing.
Carl, Roscoe J., a, Bath.
Coad, Kate M., w, Williamston.
Davis, Elva R., w, Ionia.
Dunks, Fred S., a, Union City.
Feldcamp, Cora L., w, Ann Arbor.
Ferguson, Robert Earle, a, Lansing.
Fisk, Alexander A., a, Colling.
Ford, Clem. C., m, South Haven.
Fowler, Richard C., m, Detroit.
Fryman, George R., m, Berrien Springs.
Gardner, Victor R., a, Lansing.
Gunnison, Alta, w, Dewitt.
Gunnison, Eddy J., Dewitt.
Hach, Charles A., m, Saginaw.
Haftenkamp, Joseph P., m, Grand Rapids.
Hinds, Sherwood, m, Stanton.
Hinkson, Bertha, w, Lexington.
Howard, Frederick B., a, Ionia.
Hunt, Horace S., m, Jackson.
Jackson, Bernice M., w, Gregory.
Johnson, C. Ernest, m, Lansing.
Johnston, Frederick L., m, Reading.
Jordan, William F., m, Morrice.
Kenny, E. Gerald, a, Chief.
Kratz, Frank J., m, Albion.
McAlpine, Bruce, m, Jackson.
McNaughton, Katherine, w, Middleville.
Newton, Robert S., m, Jonesville.
Nichols, George W., m, Grand Rapids.
Oven, Harry C., a, Dearborn.
Paddock, Bessie K., w, Three Oaks.

Palmer, Joel G., a, Orleans.
Phillips, Bessie, w, Davison.
Pickett, Anna E., w, Okemos.
Place, Edward C., a, Lansing.
Raven, Paulina, w, Brooklyn.
Reed, Clarence A., a, Howell.
Richardson, Sadie, w, Bath.
Robinson, Walter P., m, Detroit.
Rupert, Edna, w, Dunkirk, N. Y.
Schaefer, John E., a, New York, N. Y.
Smith, Nelson J., a, Frankfort.
Southwick, Sophia I., w, Houseman.
Stephenson, Mark G., m, Memphis.
Sterling, Clarence D., m, Detroit.
Stevens, Ralph T., a, Santa Barbara, Calif.
Stimson, Clarence A., m, Mackinaw City.
Stringer, Clyde W., m, Otisville.
Strong, Wilfred, m, Kalamazoo.
Swales, Charles E., a, Detroit.
Taft, Lillian, w, Agricultural College.
Talladay, George F., f, Auburn, N. Y.
Thomas, John L., a, Hopkins.
Tuttle, H. Foley, a, Detroit.
Wessels, Phillip H., a, Flint.
Wilcox, Ernest A., m, Washington.

Moore, James G., B. S., '03, received the degree of Master of Science in course.

Following will be found statistics concerning our last entering classes. This data is taken from the blanks filled out by applicants for entrance, and, in some respects, is not very reliable.

	Male.	Female.	Total.
Number entering	270	81	351
Average age	19–5	20–8	....
Schools attended:			
High school	198	51	249
District	37	17	54
College	31	11	42
Private	4	2	6
Entered college on:			
High school diploma	95	38	133
Teacher's certificate	18	9	27
College standing	18	9	27
Examination	19	1	20
Age	19	1	20
High school standings	41	4	45
Eighth grade diploma	74	23	97
Support here:			
Father	129	53	182
Self	72	16	88
Parents and self	30	2	32
Mother	11	8	19
Not given	10	0	10
Guardian	1	....	1
Other sources	17	2	19
Father's occupation:			
Banker	1	3	4
Carpenter	4	....	4
Clergyman	3	3	6
Clerk	4	2	6
Deceased	19	10	29
Editor	3	....	3
Engineer	5	....	5
Farmer	98	18	116
Hotel keeper	2	....	2
Laborer	4	1	5
Lawyer	7	....	7
Manufacturer	6	6	12
Mechanic	9	5	14
Merchant	39	17	56
Miscellaneous	40	13	53
Painter	2	1	3
Physician	8	2	10
Real estate	3	....	3
Salesman	11	....	11
Teacher	2	....	2
Proposed occupation:			
Chemist	2	....	2
Engineer	116	....	116
Farmer	43	....	43
Forester	14	....	14
Horticulturist	2	....	2
Miscellaneous	19	8	27
Not given	40	21	61
Stockman	4	....	4
Teacher	4	39	43
Undecided	26	13	39

Church membership.

	Members.	Preference.	Totals.
Baptist	16	26	42
Catholic	10	2	12
Christian	3	2	5
Christian Science	1	....	1
Congregational	18	42	60
Disciple	2	....	2
Episcopal	13	11	24
Evangelical	2	1	3
Friends	....	1	1
Holiness	....	1	1
Lutheran	3	2	5
Methodist	33	70	103
No preference	....	....	34
Presbyterian	17	21	38
Reformed	4	2	6
United Brethern	2	1	3
Universalist	2	9	11

Counties represented in the Entering Class.

Allegan	8	Kent	18
Alpena	1	Lake	1
Arenac	3	Lapeer	5
Barry	6	Lenawee	5
Bay	4	Livingston	10
Benzie	3	Mackinac	1
Berrien	7	Macomb	1
Branch	2	Marquette	3
Calhoun	6	Mason	1
Cass	3	Mecosta	1
Charlevoix	2	Midland	5
Cheboygan	1	Missaukee	1
Chippewa	1	Montcalm	1
Clinton	10	Muskegon	3
Crawford	1	Newaygo	2
Dickinson	3	Oakland	4
Eaton	6	Oceana	5
Emmet	3	Ontonagon	1
Genesee	6	Osceola	2
Gladwin	1	Ottawa	6
Grand Traverse	1	Saginaw	6
Gratiot	3	Sanilac	2
Hillsdale	6	Shiawassee	10
Houghton	1	St. Clair	6
Huron	1	St. Joseph	1
Ingham	56	Tuscola	7
Ionia	1	Van Buren	8
Iosco	3	Wayne	23
Isabella	2	Washtenaw	3
Jackson	9	Wexford	4
Kalamazoo	3		

Other States Represented.

California	1	Missouri	1
Connecticut	2	New York	14
Cuba	1	Ohio	2
Illinois	3	Pennsylvania	1
Indiana	2	Philippine Islands	6
Kentucky	1	Texas	2
Massachusetts	1	West Virginia	1
Mexico	1	Wisconsin	1
Mississippi	1		

Information concerning the work of the various departments of the Colege will be found in the following reports of the heads of departments.

Respectfully submitted,

J. L. SNYDER.

REPORT OF THE DEPARTMENT OF PRACTICAL AGRICULTURE.

To President J. L. Snyder:

The following is the report of the Department of Practical Agriculture for the year ending June 30th, 1905.

DIVISION OF ANIMAL HUSBANDRY.

During the year the head of the department was ably assisted by Mr. H. W. Norton, not only in the live stock instruction work, but in the conduct of live stock experiments and compilation of data from the same, as well. His work also comprised the keeping of various herd records and registration of live stock. At the beginning of this year Mr. L. F. Bird, of the M. A. C. graduating class of '04 was appointed to assist in this department, his duties comprised the supervision of part of the live stock investigation work and also some instruction work in live stock.

At the beginning of this year there was a very marked increase of four and five year agricultural freshmen entering the institution, the numbers registering in these courses being 49 and 57 respectively, making a total of 106 in addition to 11 specials. The registration of short course students in live stock was also unusually large, numbering 78 men. These large classes rendered it very difficult to do satisfactory work in the study of breeds and live stock judging with our present inadequate equipment for this work. The following data indicates the number of students who received instruction in animal husbandry subjects and the amount of time devoted to each subject.

STUDY OF BREEDS AND STOCK JUDGING.

For freshmen, sub-freshmen, specials and others. Fall term 119 men, 10 hours per week for 12 weeks.

ADVANCED STOCK JUDGING.

For seniors, specials and others. Fall term, 15 men, 10 hours per week for 10 weeks.

METHODS OF REGISTRATION, MEAT CUTTING, AND COMMERCIAL LIVE STOCK.

For seniors, specials and others. Winter term 20 men, 10 hours per week for 12 weeks.

STOCK BREEDING.

For sophomores, specials and others. Winter term 54 men 5 hours per week for 6 weeks.

STOCK FEEDING.

For juniors, specials and others. Spring term, 12 men 5 hours per week for 12 weeks.

SPECIAL LIVE STOCK SHORT COURSE.

Seventy-eight men, 10 hours per week for 6 weeks.

The work given in the live stock course has been greatly strengthened since the subject of animal nutrition has been taken up by Prof. Kedzie, as those taking this subject now not only receive lectures but conduct or follow live stock experiments actually working out the essential features in the form of laboratory investigations.

In numbers the live stock equipment is much the same as the preceding year, though the general quality of the herds and flocks has been improved; this is true of swine and sheep in particular, in both instances the breeding females have been carefully selected and new rams and boars of the various breeds have been purchased. About the middle of the year twenty grade cows were purchased as a foundation for the establishment of a grade dairy herd to be used for breeding and feeding experiments. In order to properly handle the grade dairy herd and their progeny the original grade herd barn and silo located within a few yards of the new dairy barn were moved and the barn refitted with new floor and stall fixtures, so that it will now accommodate over fifty head of cattle, young and old.

The farm building equipment consists of over a dozen structures of various shapes and sizes promiscuously located. Some of these buildings and their fittings are very old, in some instances forty years or more. As a result of their scattered locations the work of feeding and caring for the animals is greatly increased, much fertilizer is lost because of excessive yardage, and those who visit the institution seldom see but a part of the live stock equipment or experimental animals. For these and several other urgent reasons we felt justified in asking for a special appropriation to move the barns back from the campus, centralize and remodel them with up to date practical equipment. As the last state legislature appropriated funds for this purpose the plans have been prepared and the actual work is about to begin. We regret that owing to the late date of the appropriation this work cannot be completed during the present year.

As a large amount of the college farm was fenced with woven wire and other sorts of wire fencing at one time, some ten or twelve years ago or more, we find that the earliest of this fencing needs replacement which is being accomplished in part each year. This year nearly three hundred rods of new fence has been erected.

Field No. 5 which was set aside last year to be used exclusively for forage soiling and root crops has been more thoroughly underdrained and platted into two acre lots so that records relative to the various crops can be made and kept. The various forage, soiling and root crops started in field No. 5

and also in the hog lots were almost totally ruined by the unprecedented flood which occurred early in June. Smaller areas of other field crops as corn and oats were also destroyed by standing water. As far as possible these areas were resown.

DIVISION OF AGRONOMY.

Prof. Jeffery reports the following relative to his division:

The year just closed has been a very busy one for the Division of Agronomy. Seventy-nine students received instruction during the fall term, 176 regulars and 90 specials during the winter term, and 110 during the spring term.

Instructor L. B. McWethy has done good work during the year. A part of the work has been entirely in his charge. In the rest he has to a greater or less degree assisted.

Our work in field crops and soils is being extended along practical lines and the results have been gratifying. More room is needed for our work with seeds and grains and it is earnestly desired that a part of the old machine barn may be put in shape in the very near future for this purpose.

The organization of the Michigan Corn Improvement Association in the spring of 1904 has resulted in increasing demands upon us for assistance. Three large corn meetings were attended this year. These called for talks, instruction and corn judging—this in addition to the annual meeting of the association. Already a number of calls have been made for help for the coming year. Corn growers are asking for seed of pure breeds of corn that may be grown in Michigan. As time and means will permit we are studying the breeds of corn grown in the state and are working to establish pure breeds suited to Michigan conditions. The experiment station is co-operating with us in this matter.

The usual amount of institute work has been done.

DAIRY DIVISION.

Mr. F. O. Foster reports the following relative to his division:

The figures on the quantity of milk handled, butter and cream sold, supplies purchased, expenses for labor, etc., you already have on file.

The number of students given instruction in dairying during the year was as follows:

In the regular courses:

Elementary Dairying	59 students, 12 weeks
Advanced Dairying	1 student, 33 weeks
	1 student, 12 weeks
	1 student, 9 weeks
Household Dairying	4 students, 12 weeks

In the short courses:

Creamery course	52 students, 8 weeks
Cheese course	28 students, 4 weeks

A few lessons were given to the class in live stock and general farming.

As the work was placed in new hands at the beginning of the year it would seem fit to give at this time, the present plan of instruction in dairying.

The work was arranged to suit the time allotted to dairying, no change in hours being asked for. For elementary dairying the time allowed is six hours a week for twelve weeks. It seemed desirable to introduce either a series of lectures or a text book as a part of this work, and the schedule was changed so that the class came for two lectures and four hours of laboratory work weekly. The course in household dairying was arranged in a similar manner.

Because of the fact that only a few of the students get the advanced work in dairying, the endeavor is made to give under the head of elementary dairying, not only a thorough study of, and practice in, farm dairy work, including the hand separator and other methods of creaming, the Babcock milk test, cream ripening and butter making under farm conditions, handling milk and cream for city consumption and for delivery to creameries and cheese factories, etc., but also a general knowledge of the whole subject of dairying, taking up briefly, factory methods of making butter and cheese, how factories are organized and operated, city milk plants, condenseries, the use of modified milk and special milk products, butter judging, the detection of adulteration and preservatives, etc.

Under the advanced dairying is taken up in detail what was but briefly mentioned in elementary dairying. The fall term's work is divided into two parts, one-half of the term being devoted to creamery work, including pasteurization and the use of pure cultures in cream ripening, a study of creamery machinery and methods, the operation of creameries on the whole milk and gathered cream system, etc. The other half of the term is given to a study of the city milk and ice cream business, preparation of modified milk, pasteurization, etc.

A trip of inspection is made through a separator factory, milk condensery and creamery. Text book and lecture work occupy four hours and laboratory work six hours weekly.

During the past year, as has been the custom in previous years, the entire winter term was given to the advanced dairy student for experimental work. Judging from the work done and from the instructor's own experience, a part of this term can be more profitably spent studying dairy literature, methods of inspection and detection of adulterations and preservatives in dairy products, and the work is so planned for the coming year.

The spring term is devoted to cheese making, three hours a week in the class room and seven hours in the laboratory. Decker's cheese making is used as a text supplemented by lectures and bulletins.

Michigan, Cheddar and Cottage varieties are made and foreign kinds studied.

For the class in household dairying the subject is treated from the standpoints of both the producer and the consumer.

A series of lectures is given dealing with the composition and properties of milk and milk products, the food value, economic use and care of dairy products on the farm and in the home, methods of producing and handling milk, cream, butter, cheese, ice cream and special milk products, the modification of milk for infant feeding, the testing of milk for butter fat, impurities, adulterations and preservatives, etc.

Laboratory work in creaming, buttermaking, testing, etc., accompanies the lectures.

During the winter term the instructor's time was largely taken up with special course work.

In addition to handling and testing the milk from the college herd considerable testing of milk and cream has been done for creameries and dairymen, and all correspondence faithfully attended to.

We are glad to report that the progress of the work of the entire department has been very satisfactory and the support the department has received during the year has been very gratifying.

Yours respectfully,
R. S. SHAW,
Professor of Agriculture.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE MECHANICAL DEPARTMENT.

To the President:

I have the honor of submitting the following report of the work done in the Mechanical Department during the year ending June 30, 1905.

The work in the class rooms, drawing rooms, etc., has been conducted as follows:

Fall Term.

Subject.	Required hours per week.	Total hours of instruction per week.	Method of instruction.	No. of students.	Year.	Instructor in charge.
Carpentry and wood turning	10	20	Shop	91	Sub-freshmen	Mr. Krentel. Mr. Baker.
Visits of inspection	4	8	Visits and lectures	96	Sub-freshmen	Mr. Shedd. Mr. Balbach.
Forging	6	18	Shop	54	5-yr. freshmen	Mr. Chappell. Mr. Smith.
Carpentry and wood turning	10	20	Shop	60	4-yr. freshmen	Mr. Krentel. Mr. Baker.
Chipping and filing	12	24	Shop	81	Sophomores	Mr. Leonard. Mr. Crawford.
Foundry	12	24	Shop	26	Sophomores	Mr. Baker.
Forging	12	12	Shop	20	Sophomores	Mr. Chappell.
Machine shop methods	2	8	Lectures	100	Sophomores	Mr. Leonard
Metal turning, iron, etc	6	18	Shop	45	Juniors	Mr. Leonard. Mr. Chappell.
Machine design	6	6	Drawing	21	Juniors	Mr. Blair.
Metallurgy	1	2	Lectures	46	Juniors	Mr. Shedd.
Experimental laboratory	4	8	Laboratory	29	Seniors	Mr. Blair.
Elementary kinematics	2	4	Recitation	29	Seniors	Mr. Shedd.
Steam engine design	6	6	Drawing	12	Seniors	Mr. Shedd.
Thermodynamics	5	5	Recitation	29	Seniors	Mr. Wells.
Machine tool work	6	6	Shop	6	Seniors	Mr. Leonard.
Graphical statics mechanism	4	4	Drawing	28	Seniors	Mr. Wells.

Winter Term.

Subject.	Required hours per week.	Total hours of instruction per week.	Method of instruction.	No. of students.	Year.	Instructor in charge.
Carpentry and wood turning	8	16	Shop	80	Sub-freshmen	Mr. Krentel. Mr. Baker.
Carpentry and wood tnrning*	10	20	Shop	45	Sub-freshmen agricultural	Mr. Krentel. Mr. Baker.
Forging	6	12	Shop	48	5-yr. freshmen	Mr. Chappell. Mr. Smith.
Pattern Work	6	12	Shop	57	4-yr. freshmen	Mr. Krentel. Mr. Baker.
Carpentry and wood turning*	10	10	Shop	53	4-yr. freshmen agricultural	Mr. Krentel. Mr. Baker.
Machine design	6	12	Drawing	81	Sophomores	Mr. Blair.
Chipping and filing	8	16	Shop	57	Sophomores	Mr. Leonard. Mr. Crawford.
Foundry	8	16	Shop	25	Sophomores	Mr. Baker.
Forging	8	8	Shop	23	Sophomores	Mr. Chappell.
Steam engine design	8	8	Drawing	21	Juniors	Mr. Wells.
Machine design	8	8	Drawing	21	Juniors	Mr. Wells.
Steam boilers	2	4	Recitation	57	Juniors	Mr. Wells.
Valve gears	2	4	Lectures, drawing	45	Juniors	Mr. Wells.
Machine tool work	12	24	Shop	37	Juniors	Mr. Leonard. Mr. Chappell.
Machine design	10	10	Drawing	13	Seniors	Mr. Leonard.
Advanced kinematics	5	5	Drawing	28	Seniors	Mr. Shedd.
Steam engineering laboratory	8	16	Laboratory	23	Seniors	Mr. Shedd. Mr. Crawford.

*Agricultural student. Six weeks.

Spring Term.

Subject.	Required hours per week.	Total hours of instruction per week.	Method of instruction.	No. of students.	Year.	Instructor in charge.
Pattern work	10	20	Shop	64	Sub-freshmen	Mr. Krentel. Mr. Baker.
Chipping and filing	6	12	Shop	40	5-yr. freshmen	Mr. Crawford.
Pattern work	12	24	Shop	45	4-yr. freshmen	Mr. Krentel. Mr. Baker.
Chipping and filing	12	12	Shop	31	Sophomores	Mr. Leonard. Mr. Crawford.
Foundry	12	24	Shop	39	Sophomores	Mr. Baker.
Forging	12	24	Shop	31	Sophomores	Mr. Chappell. Mr. Smith.
Steam engine	4	16	Recitation	70	Sophomores	Mr. Shedd. Mr. Blair.
Machine design	4	8	Drawing	72	Sophomores	Mr. Blair.
Machine tool work	8	8	Shop	11	Juniors	Mr. Leonard. Mr. Chappell.
Theory of design	2	2	Lectures	18	Juniors	Mr. Wells.
Strength of materials	5	10	Recitation	47	Juniors	Mr. Wells.
Strength of materials, laboratory	2½	15	Laboratory	46	Juniors	Mr. Shedd.
Engineering practice	2	2	Lectures	28	Seniors	Prof. Weil.
Original design	6	6	Drawing	13	Seniors	Mr. Leonard.
Thesis	10	20	Laboratory	21	Seniors	Prof. Weil. Mr. Shedd.

NOTE: The actual number of hours of instruction exceeds the hours required per student in the case of certain subjects on account of the necessity of handling classes in these subjects in sections.

The total number of students enrolled in the Mechanical Department during the year was three hundred and eighty (380).

In June, 1904, Mr. George Tryon, after serving the Department efficiently, as instructor, during the year following his graduation, resigned in order to engage in practical engineering work. Mr. O. N. Blair, a graduate of the Kansas State Agricultural College, was engaged in September, 1905, to take the position vacated by Mr. Tryon.

Mr. Paul Theodore, who had been connected with the Department as foreman of the forge shop for a period of over fifteen years, and who had made a most excellent record as an instructor both in the forge shop and machine shop, resigned his position in August, 1904, and entered the employ of a Lansing manufacturing concern. Mr. Theodore's resignation was exceedingly regretted, not only by the officers of the Department but by the faculty as a whole,—his long period of service having led to a general appreciation of his ability as an instructor. In September, 1904, Mr. Lee Chappell, of Detroit, was engaged to take the position vacated by Mr. Theodore.

The latter part of August, 1904, Mr. Herman W. Reynolds, assistant professor of mechanical engineering, tendered his resignation in order to accept a professorship at the University of California. Mr. Reynolds had been with the department over a period of four years, during which time, he served the Department efficiently as instructor, senior instructor and assistant professor.

Mr. W. W. Wells, formerly an instructor at this college, but recently with the Ball Engine Company of Erie, Pa., was retained as an instructor in this Department, in September, 1904.

In our last report, we stated that owing to the number of students handled and the consequent necessity of carrying on the Department pay roll several special assistants, the yearly increase in equipment could be but limited under the apportionment allowed. During the past year, we regret to say, there has been no important addition to the equipment of the Department.

As a matter of record, we must again refer to the just need in the Department of additional room for classes. The failure to provide such room will, in our opinion, lead to a material decrease, in the immediate future, in the attendance of engineering students at this college.

During the past year a large amount of work has been carried forward in connection with the central heating, lighting and power plant planned by the writer. The system of tunnels called for by the plans has been completed. Murray & Ayres of Saginaw, Michigan, were the contractors for the tunnel work. The power house has been practically completed, Hoertz & Son of Grand Rapids, Michigan, being the general contractors and the Russel Wheel & Foundry Company of Detroit, Michigan, being contractors for the structural steel work. Four boilers with stoker equipment have been installed in the house. The steam piping has been installed in the tunnels and practically covered, this work having been done by the College. Numerous details in connection with the work has been finished, such as making a river connection for pumps, also well connection for pumps, etc.

I take this opportunity to express my appreciation of the services rendered

the Department by my immediate associates during the year, also my appreciation of the co-operation of Mr. L. F. Newell in carrying out the many details of the work in connection with the new central plant.

Respectfully submitted,

CHAS. L. WEIL,

Professor of Mechanical Engineering
and Director of the Mechanical Department.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE WOMEN'S DEPARTMENT.

To the President:

The Women's Department has enrolled during the year 1904-'05 about the same number of students as in each of the past two years,—two hundred seven being the total number.

The courses which have been carried are shown in the following table:

	Fall.	Winter.	Spring.
Miss Gilchrist	Ethics	Ethics	History of education.
	Sewing	Sewing	Sewing.
Mrs. Haner	Wood work	Wood work	Wood work.
Miss St. John	Hand sewing	Hand sewing	Art needle work.
	Dress making		Millinery.
Miss Carpenter	Cookery	Cookery	Cookery.
Miss Purmort	Advanced cookery	Home economics	House architecture.
Miss Bemis		House keeping	Invalid cookery.
Mrs. Barber	Home nursing.		
Miss Freyhofer	Theory of music		History of music.
Miss Mack	Piano	Piano	Piano.
Miss Avery	Gymnasium	Gymnasium	Gymnasium.

Mrs. Haner, after a year's study at Drexel Institute and a summer abroad, was warmly welcomed on her return in September to resume her work in Domestic Art.

At the end of the winter term the resignation of Miss Carpenter went into effect. Her marriage in May to Capt. Mark Wheeler of the United States Army, whose regiment is now stationed in the Philippines, was one of the events of the college year. The department regrets to lose her, but at the same time, extends hearty good wishes to her for the future. Miss Purmort at once assumed the duties of senior instructor, in charge of Domestic Science, and carried the work most efficiently. She was ably assisted by Miss Bessie Bemis, of the class of 1905, who had practically finished the work required for the degree and could give most of her time to teaching.

The department is sorry to lose from its corps of instructors Misses St. John, Purmort, and Mack, who have all done excellent work and made many friends while with us. As they look forward to positions with larger responsibility and better salary, we can but wish them the highest success.

Night classes in cookery and physical training have been carried on during the year, while work in sewing has been given by some of our students to the 5th and 6th grades of the Lansing City Schools. Reports of this work have been very satisfactory, and it is of great value to the students who do the teaching.

Twenty-four women were graduated in the class of 1905, the largest

number in the history of the department. We believe these young women are as well equipped for life and its duties, as any in the land, and better equipped than many of the women graduates of the year. The value of practical training is becoming more and more apparent and we look forward with hopeful anticipation to the establishment of courses in Home Economics in all the higher institutions for women.

Respectfully submitted,
MAUDE GILCHRIST,
Dean of Women's Department.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF FORESTRY.

To the President:

I have the honor to submit herewith the third annual report of the Department of Forestry for the fiscal year ending June 30, 1905.

In August a visit was paid to Allegan county and as a result forestry has been much encouraged in that county. A small company has been formed for the purpose of growing timber. This is the first organization of its kind in the state according to the best of my information. Forty acres of land have been purchased for the purpose, one acre of which has been planted and seed has been sown for growing more trees.

Improvements in the College timber land has been continued. In number 20 some thinning has been done to encourage the more valuable growth. Several of the larger injured trees have been cut out and sold in cord wood. In November four bushels each of black walnuts and butternuts were planted in the more open places where trees had been removed.

The timber on number 19 is all cull stuff and poor at that for the most part. One acre of this timber on the east end was cut off last winter. The yield was 98½ cords of 16-inch stove wood. Although this is an inferior class of wood the net returns are 90 cents to a dollar per cord. For hard wood the net value is $1.25 to $1.40. The acre has been stocked with white ash from our own nursery. The trees are at this writing growing rapidly.

Experimental planting has been continued on the west end of number 18.

A row of trees following the course of the Red Cedar river and 25 feet from its west and south bank has been planted from the bridge leading to the athletic field to some distance beyond its intersection with the farm lane along the north line of field number 7. It is expected in time to carry out the plan of a drive from the bridge above mentioned through number 20, which is to be made into an arboretum, to the pinetum, a distance of considerable over a mile, which will be the most pleasant drive in the neighborhood of the capital of the state.

The vacancies caused by failure in the rows of trees along the farm lane have been supplied. The trees for both these purposes were volunteer stock from the side of the highway south of number 19. Thus these valuable trees which would cost 25 to 50 cents each if purchased from the nursery have been utilized and the roadside improved.

White pine seed was secured from cones shipped from N. H. In this

way the seed cost $1.44 per pound which is considerable below the market price.

Nursery work has been continued and extended. The nursery at present contains about 60,000 coniferous and 100,000 hardwood seedlings. The nursery now supplies nearly all the stock used in our planting. About 8,000 trees were planted into permanent situations this spring. No trees have been purchased except 1,250 small arbor-vitae. A tool-room at the nursery has been erected at a cost of about $40.

The number of photograph plates has been increased to 447 and lantern slides to the number of 105.

The collections have been greatly increased during the year. We have acquired over 700 different numbered pieces of wood from the Philippine Islands; 56 pieces of wood from Venezuela; 15 pieces of wood from Honduras; 14 pieces of wood from Haiti; 11 pieces of wood from Cuba; 22 pieces of wood from California. From Japan numerous specimens of timber and forest products. Numerous specimens of woods from our own state have been secured. The number of herbarium specimens has been increased. We are greatly in need of more room in which to exhibit these specimens. They are now placed in four different buildings in no one of which is anything like suitable quarters.

The entire schedule of classes in this department has been carried out as far as time would permit. For lack of assistants and on account of the large number of students in elementary forestry it was found impossible to give the class the full amount of work designed. There were fifteen students registered for forestry in the fall of 1904 as against four the fall of 1903. The total number of different students that have received instruction in this department this year is 67. The number of hours per week of my time for class work has varied from 22 to 29.

The correspondence of this department is increasing and takes no small amount of my time. Attempts have been made to secure assistance in this but no satisfactory arrangement has been made.

Respectfully submitted,
E. E. BOGUE,
Professor of Forestry.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF HORTICULTURE.

To President J. L. Snyder:

I herewith submit the annual report for the Horticultural Department for the college year ending June 30, 1905. With this report my third year in charge of this department is ended, and with it I shall sever my connection with your institution. It is fitting, in thus concluding the term of work, that a brief sketch of the progress of the past three years be given.

During the time the department has been in my hands, the chief aim, almost the sole aim, has been to build up the work of instruction, which, it seemed to me, had fallen behind that of other departments of the college, and behind other lines of work which came into my hands. A fair measure of success has attended the effort, as manifested by a greater num-

ber of students taking the work in horticulture; by far better facilities for teaching; by the successful change from the wholly unsatisfactory system of student labor to a system of laboratory courses; and by a much better grade of work from the students.

The chief changes in the equipment of the department during the past three years have been in the laboratory, the interior of which has been practically remodeled. For the old tool-room, carpenter shop, and post-office, which occupied the main floor of the building, two good laboratory rooms have been substituted. A third laboratory room has also been added in the basement. On the upper floor a small laboratory for plant diseases, an herbarium and stock room, and the club room for the student Horticultural Club, have been furnished. Possibly the most valuable addition to the building, however, is a small, but perfectly equipped greenhouse, the generous gift of the Lord & Burnham Green House Construction Co. The main range of greenhouses, built and chiefly used in the past for show and commercial purposes, has been almost rebuilt to adapt the various houses to laboratory purposes, for which they are now used almost exclusively.

But the most satisfactory improvement, has been the addition of a number of courses in horticulture, and the increased number of students taking them. Fifteen courses are now offered by the department. These are, with the number of students taking them:

Plant Propagation and Vegetable Gardening	70
Laboratory Work in Above Course	55
Pomology	25
Laboratory Work in Pomology	25
Landscape Gardening	18
Floriculture for Women	18
Floriculture and Vegetable Forcing	8
Laboratory Work in Floriculture and Vegetable Forcing	8
Spraying of Plants	4
Laboratory Work in Spraying of Plants	4
Plant Breeding	16
Harvesting and Marketing	16
Evolution of Horticultural Plants	14
Experimental Horticulture	14
Forest Tree Propagation............(Added this year)	
Total	295

To handle the above number of students the time and attention of the head of the department, and of all the assistants has been very fully occupied. At the beginning of the school year the services of Mr. A. G. Craig were secured as an additional instructor. In the spring term still more help was required, and Mr. J. G. Moore was secured as a student assistant. With these exceptions, the personnel of the department remained the same as in the past year, Mr. Thomas Gunson, Mr. C. A. McCue, and Mr. Clifford Gibson constituting the other members of the department staff. It gives me pleasure to say that all the men with whom I have been associated have performed their duties faithfully, and have added much to the pleasant running order of the work in teaching.

But few changes have been made in the orchard, garden and campus

worthy of note. During the past winter about 1,500 loads of mulch were hauled from the pond in the rear of the Woman's Building and spread on the campus and garden, with most excellent results. By draining the pond in the fall, this can be repeated from year to year without great expense, thus obtaining a fertilizer quite as valuable for the lawns at least, all things considered, as barnyard manure. During the year the ground disturbed in putting in the tunnel system the year previous has been reconverted into lawn. The building erected several years ago for the cold storage of fruits, and which was well-nigh worthless for the purpose, has been remodeled and the Cooper system of refrigeration installed. It has not been possible to test the plant thoroughly as yet, but it seems to work perfectly and the department will have added to its equipment a means of keeping fruit for class and commercial work. Early this spring a hydraulic ram was placed at the dam in the river to supply the artificial pond with a suitable amount of water.

As stated before, the efforts of the department have been largely devoted to teaching, possibly somewhat to the neglect of other matters. It is hoped that the teaching is left in such shape that my successor will be able to give more time and more of the funds of the department to the other lines of work in the department than I have been able to do.

In handing you this report, Mr. President, I must express my very great satisfaction with the relations which have existed between this department and the government of the college. In all that relates to the teaching of students, the relations have been ideal, as they have indeed in most other respects, but I have to record for the good of the department in the future, my very great dissatisfaction with one or two phases of the work.

The non-professional work of delivering ice, hauling coal, caring for garbage, and doing the general utility work of the college community, has been most annoying and burdensome at all times. Nor can such matters be attended to by assistants, as you have so often suggested to me, for requests and complaints will be thrust upon the head of the department as long as the work is in his charge. Much of my time for the past three years has been spent in bickering with people of the community over their affairs as related to the above tasks required of this department. I again protest against the continuance of this disagreeable, non-horticultural work.

I must call your attention also to the fact that the instruction of the students in the greenhouses is most seriously interfered with and the finances of the department greatly depleted by the custom of furnishing the Legislature, State, and college officials with flowers and plants. In my opinion, this custom should be almost wholly stopped; or failing in this, it should be regulated by the State Board of Agriculture. In the latter case my recommendation is that the college be asked to pay the department for all such donations, and that no presents whatever be made of flowers or plants to state or college officials except upon the written order of the President of the college.

In closing this brief report, I must express my thanks to you and to the State Board of Agriculture, for the hearty and generous support you have given to me to make the Horticultural Department more helpful to the students of your college and more valuable to the people of the state.

Respectfully submitted,

U. P. HEDRICK,

Professor of Horticulture.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF BOTANY.

President J. L. Snyder:

I hand you this my report for the year ending June 30, 1905. A summary of the classes and number of students receiving instruction is as follows:

Class.	Subject.	Term.	Hours per week.	Students enrolled.
Seniors, women	Plant physiology	Fall	6	9
Seniors, agricultural and forestry	Plant physiology	Spring	6	8
Seniors, agricultural	Parasitic fungi	Fall	9	19
Juniors, agricultural and others	Grasses and weeds	Winter	4	14
Juniors, forestry	Wood technology	Winter	8	2
Juniors, agricultural	Trees and shrubs	Spring	2.5	5
Sophomores, agricultural	Histology	Winter	9	49
Sophomores, women	Trees and shrubs	Spring	2.5	26
Sophomores, agricultural	Ecology	Spring	3	55
Sophomores, women	Systematic	Spring	3	25
Freshmen, agricultural	Fruits and seeds	Fall	4.5	71
Freshmen, women	Fruits and seeds	Fall	4.5	47
Freshmen, agricultural	Systematic	Spring	3	60
Freshmen, women	Histology	Spring	7	26
Sub-freshmen	Beginning	Fall	2	6
Sub-freshmen	Beginning	Spring	2	58
Short course	Beginning	Winter	2.5	10
Short course	Beginning	Winter	1.7	76
Total				566

THE LOUISIANA PURCHASE EXPOSITION AT ST. LOUIS.

After considerable correspondence, I sent for the exhibit of colleges of agriculture and mechanic arts and experiment stations the following items:

1. A syllabus of our teaching in botany.
2. Six charts showing in variety our method of exhibiting grasses, weeds, and the like.
3. Four jars of seeds of weeds, showing our plan of exhibition.
4. A number of photographs, about 35.

The space for the exhibit was very limited, and although I sent but very little material, such as they accepted, yet there was not room to display all that I forwarded. Some photographs were sent to the U. S. Department of Farmer's Institutes.

THE BOTANIC GARDEN.

In 1870, when the present professor of botany began his work at M. A. C., he set to planning, in a modest way, and in the spring of 1877, 27 years ago, without any endowment, moved a few wild plants from neighboring fields, woods, and bogs, and set them on the sloping bank and the low land northwest of the present greenhouse.

I thought a very small garden just as well to experiment with till experience had enabled me to make few mistakes. By a slow process at little cost, I have learned that a garden cannot be planted once for all time, without a great cost of changing the earth about the plants. Herbaceous plants need a rotation, a change from one place to another. The soil becomes depleted of certain elements, or the physical conditions are not right; insects and fungi find their favorite plants and settle down in great numbers to feed and multiply.

Had I waited for $5,000 a year or possibly even $500, the garden would have been delayed for many years, if it were begun to this day. I had read a great deal about growing plants in pockets on a shady slope, the pockets surrounded by boulders. Rockwork and pockets were thoroughly tested during several seasons, till I became convinced that, however well these might answer for the cool, damp summers of Great Britain, they are not successful in Michigan. Most herbaceous plants thrive better on level ground, and when trees and shrubs are near, the latter get nourishment that the cultivated herbs suffer for. During twenty-seven summers the garden has had no change of management, and has gradually been much improved as the director acquired more experience. Evolution is the word which emphatically applies to this garden.

One horticulturist in particular has claimed that the area now under cultivation is not a botanic garden, because there is not included under the same management greenhouses, a library, a botanical museum. The museum we once had, and have not despaired of having another. It is true the greenhouses managed by the horticultural department, while they are useful to that department, are of very little use to the botanical department.

The spot for the location of our garden was very fortunate. Most of it is situated on both sides of a brook, and portions of it on a raised flat of Cedar river. In this place, depressed eight or ten feet, the whole may be seen to good advantage from the surrounding banks. The soil of the flats is good, suffering little for moisture. Before used for a garden, the spot contained two or three rubbish piles, and was otherwise unsightly by growing coarse grasses, sedges, thistles, wild parsnips, and briars. While such a place is most suitable for a garden, it is also likely to insure permanence, as no college authorities are likely to covet the ground for buildings.

The area of the garden is now just about an even two acres, and contains very nearly twenty-three hundred species and varieties of seed-plants and ferns. The garden is approximately the shape of a capital letter T.

Not counting considerable of my time, especially during the long vacation, the annual expenses of the garden, with its present size, are not far from $900.00, by far the cheapest garden of its size and quality of any within my acquaintance. Our good Professor of Horticulture says that it ought to be much extended, and should cost not less than $5,000.00 per year.

For convenience there are at irregular intervals seven foot-bridges extending across the brook. These as well as the location of paths, bogs and ponds, are indicated on the map. In my report for 1882, printed in the Report of the Secretary of the State Board of Agriculture, appears a neat map of the garden, then consisting of about one-third of an acre, on which were cultivated not far from 700 species of seed-plants. The map was prepared by W. S. Holdsworth, '78, then instructor of drawing.

I briefly quote from that report.

"In the north part of the garden, a rustic foot-bridge, some seven feet high spans the ravine. In several places rustic seats have been constructed.

"The garden is divided into wards, each of which is numbered, and opposite the numbers appear the names of the families occupying that special area.

"A label of locust wood stands near each plant.

"The labor has all been done by students under my oversight."

An alphabetical list of the plants closes my report for 1882.

In my report for June, 1895, appeared a new map of the garden, then containing 1,335 species, and varieties of plants, double the number grown thirteen years previous. The excellent map was prepared by B. O. Longyear, then instructor of botany.

I quote from this report:

"In visiting this garden, a farmer can compare some of the newer untried sorts of grasses or other forage plants by the side of his old favorites, or he can see behind a label containing the name of some weed-pest that has lately found its way into his neighborhood. The beekeeper looks for the plants and their names where honey is gathered in most abundance. The entomologist learns to look for certain insects on the plants of a certain family or species. At a farmers' institute, last winter, no topic attracted greater attention than the mention of a family of mints represented by some sixty species in our botanic garden. Several present expressed a determination to pay the garden a visit for the purpose of looking for something new and promising for distillation. They hoped we would extend the list by introductions from other countries.

"Many kinds of pretty wild plants are not well known by people in general, especially since the woods have been cut away or pastured and the swamps drained and placed under cultivation, or frequently burned over. Even along the roadside, in many places the fences have been removed and grasses, grains, and potatoes come nearly to the tracks of the wheels.

"In the vicinity of a college or high school, the herbarium fiend ransacks the wild places for choice plants which he removes root and branch in large numbers. Sometimes the roots are removed to supply the eastern market. By these methods the choicer plants are driven farther and farther over the hills or back into remote swamps and small patches of forest. A botanic garden of some extent is now becoming almost a necessity for supplying students of school or college with suitable materials for illustration and study."

Under a lath screen raised six to eight feet above a rich bog, an effort was made to grow mosses and a few seed-plants. My effort to grow mosses was not crowned with success and the project was soon abandoned. I grow successfully patches of a considerable number of bog plants near each other, by diligently weeding out all suckers every week or two during the growing season. Among such plants are arrow-head, bur-reed and bulrushes.

The garden at this date contains 2,200 to 2,300 species and varieties, including no greenhouse plants, and no bedding plants. Most of the plants are obtained by making excursions to the neighboring districts, but many are purchased from nurserymen ranging from Colorado to Georgia, and a few are obtained as gifts or by exchange. The directors of several botanic gardens, including those of Kew, England, have sent me their catalogs of seeds for free distribution. For seeds from these gardens we are very thankful.

At one time, I grew the worst weeds, a hundred or more of them, in patches five to six feet in diameter, each species by itself, but recently the weeds are grown with others of the family to which they respectively belong, where any one may see at a glance what are the weed-families, and what families supply plants that are ornamental.

The tool house is a little north of the pond, and is partially screened by evergreen trees. It is made of logs, with the bark remaining, neatly put together. Back of this house, are stored, under shelter, the numerous stakes used for supporting plants during the summer.

At long intervals, we have freshets, that cause the river to overflow its banks, covering portions of the garden. If a freshet comes in the growing season, and covers plants for a few days, many of them perish outright. A freshet coming at the time when the plants are at rest causes no injury, except as it washes some of them out by the roots. When the snow went off a year ago this spring, the water was nearly two feet higher than I had ever seen it before, completely covering all the flats of the river and the brook. As noticed elsewhere, the lower portion of the garden within the past two years, has been much raised by adding dirt. In the lower part of the garden, three years ago, in a space about three by four rods, I set posts extending over six feet above the ground, and on the tops of these were nailed horizontal poles over which were spread small brush, and brush was put about the sides, making a very good imitation of a forest under which to grow plants impatient of shade. The structure is not ornamental, but evergreens on the north conceal it from view. Seedlings, as well as certain other plants thrive much better under such an arbor, than in the forest, because there are no woody plants to rob them of nourishment.

Under this brush arbor are grown small quantities of many choice things usually of little interest to most visitors. Here grows some ginseng, concerning which recently many are beginning to seek information. Here grow some orchids, Shortia, Galax, wintergreen, violets, columbo, pipsisewa, Trillium, wild ginger, Dutchman's breeches, squirrel corn, holly, pinweed, lousewort, strawberry blite, firepink, lop-seed, enchanter's nightshade, tick trefoils, wild blue phlox, and its white variety, leaf-cups, and many others.

A very few have criticised the arrangement of the families as neither following DeCandolle, nor Engler and Prantl., but I do not think they realized the difficulties that must be overcome to perfect such an arrangement. So far as I thought practicable, plants are grown, each family by itself, though there are exceptional species which must be grown in shade, in bog or pond, or in dry sand. I selected a spot with suitable shade, light, size and soil to accommodate a family; for example, there was only one spot suitable for growing ferns where they would be sufficiently shaded and screened from wind. The ferns went into that spot and have thrived. A sunny, sandy slope facing the south is used for cacti, species of sempervivum, Sedum, and plants liking such a place. By these illustrations, you will see that no two areas for two families are of the same size or exactly the same shape. In this way, monotony of shape and size is avoided.

In a few instances, a family was located, as now to be seen in the garden, for the following reason: The cherries and plums, *Drupaceae*, were so placed as to include a large black cherry as one of the species already in place; another spot was devoted to the apples, *Pomaceae*, because a good-sized tree of Juneberry occupied a place there. The sumachs were placed

on a bank near a pond, because it afforded an opportunity to place the two poisonous species on an artificial island, where no one would be likely to handle them.

The limited area of the garden precluded the growth of large trees among the smaller plants. As soon as the soil in the vicinity is enriched and cultivated, the trees spring into vigorous growth as though the extra care was for their special benefit, and this growth is usually very detrimental to the success of the herbaceous plants and shrubs. For this reason, a considerable number of fine ornamental trees have been from time to time removed. In no case has a tree been removed unless there were plenty of other good specimens elsewhere at the college. The only chestnut oak on the campus is to be found in this garden. The same may be said of three kinds of locust, two kinds of red bud, honey locust and others in the garden. It doesn't seem worth while to spare a group of basswoods, a large red oak, a Wisconsin weeping willow, a well-grown American elm, a large Norway spruce, a silver maple, any one of which would make it impossible to grow to perfection twenty or more kinds of honeysuckles, spiraeas, a fine selection of phloxes, goldenrods, daisies, mints, legumes, or roses.

The slow brook that winds about through the garden passes between sloping banks that are rather artificial and monotonous. For many years these banks were mowed every two weeks during the growing season, and the labor of mowing was far from easy. During a pressure of work, these banks were left for a month or six weeks, without mowing, and then I realized for the first time, that the banks looked better for apparent neglect. Since then, we have mowed the banks but once a year, and that time is late in October when we are cutting off the dead tops of many plants.

On the banks of the brook grow to perfection, blue violets, anemones, cicuta, great-stemmed angelica, wild vetch, wild pea, ground nut, hog-peanut, swamp saxifrage, wild balsams, blue lobelia, swamp lousewort, bitter cress, water cress, blue flag, fringed loosestrife, grasses, sedges, rushes, wild asters, goldenrods, and very likely others not recalled at this moment.

Among the improvements of the past year are the addition of some cement steps in four places to go down from the high land to the garden. At the upper steps near the Physical Laboratory and those northwest of the greenhouse, hand-railings have been put in, consisting of gas pipe.

Seven spots were selected on the banks about the garden from which the best views were to be obtained, and here were placed oak benches, set on cedar posts.

For many years, the paths in the upper part of the garden have been covered with a good growth of grass that was mowed as often as needed. Well trimmed paths seem to delight visitors. During the year, nearly all the paths in the remaining portions of the garden have been seeded to grass. Until this year, many of the paths were marked by margins of cobble-stone. A small amount of the grass-paths was sodded over, all the rest put into grass by inoculation, a quicker plan than to sow grass seed. This process consists in scattering small fragments of sod on well-prepared land which was then rolled or pounded down. Wood ashes and commercial fertilizers are freely applied, nearly every year to help grow a turf sufficient to stand the tramping of many visitors. Throughout the garden pipes have been laid, which enables us to irrigate in dry seasons. When a spot in the path becomes conspicuously worn, a small stake two feet high is driven

into the worn place, where it remains for a week or two. Visitors go around the stakes, thus sparing the thin grass in the vicinity.

To grow many interesting wild plants, there have been added two rich bogs near the upper pond.

Last year, and year before, the garden was considerably enlarged. Top soil was scraped off into piles, the high banks adjoining used to fill in; and deep and extensive excavations were made on the lower side, after which the top dirt was replaced. In this way, some of the lower portions of the garden have been raised four or five feet and brought up to or above high water mark. When the excavations were made, it was understood that the holes could be filled in a year or two by surplus dirt, when the tunnels were put in. Without expense to the college, I was in autumn glad to see great quantities of earth dumped in to fill all these holes save one small place reserved for rubbish.

High water removed some of the foot-bridges, one of them going down the river half way to Lansing. As the timber and planks of such structures need renewing frequently, the five bridges of wood have all been replaced by surplus pieces of artificial stone paths taken up where tunnels were to be put down. Two pieces of steel plate were used as a portion of two of the longest and highest of the bridges. The steel and stone are supported by good cedar posts well set into the ground.

The places occupied by plants are dug over once a year, when composted manure is turned under. For many years, a hundred bushels or more of hardwood, unleached ashes per year were applied to the ground under cultivation. Surface clay from an old pasture, muck from a well-drained cat-hole, and sand have been applied liberally where these materials were most needed. Late last year the low spot south of the wild asters was raised by taking advantage of some surplus dirt from the tunnel.

During the year, plants of the family *Ambrosiaceae* were moved by themselves to a spot south of the asters, and the *Cichoriaceae* were moved across the brook near the lower bridge. These two transfers of plants formerly considered tribes of the *Compositae*, left more room for the tribe *Helianthoideae*, which had become much crowded. The grape-vine family was transferred to the central portion of the lower part of the garden, where the vines will screen the unsightly compost heap. The moon-seed and trumpet-creeper families were moved to the southwest near the grasses. The *Solanaceae* were also moved to a new place near the grasses, leaving more room for mock oranges. As the rose family became much crowded, the Spiraeas were placed on the north bank next the legumes. The Phlox family went to a sandy bank, sloping to the north, by the greenhouse, where they find a congenial home, while an increased number of Irises have been placed between the upper bog and the brook. Some of the ferns at the east, artificially screened by mosquito netting since the removal of two large Norway spruces, were moved west of the remaining ferns into the shade of blue-beeches. Aristochia macrophylla and all species of Asarum were moved into the brush arbor, as were all plants of squirrel corn, and Dutchman's breeches.

The perennial grasses were all moved north by the path, leaving room for annual grass on the south side of the garden. Our seven species of Silphium took the place formerly occupied by the *Cichoriaceae*, while the six species of balsams occupy the bank of the brook near the borage family. The species of Vaccinium have been transferred to the upper bog. The

removal of many herbaceous plants once in two to four years enables them to thrive all the better, and the labor and risk is of little moment.

Late in October, the garden is hoed over thoroughly, thus doing spring work in autumn. Some plants every fall, and this year an unusual number, are covered with a little barnyard manure, over which is usually heaped a small pile of earth. Over the bogs are placed quantities of autumn leaves, a foot or more in depth, and to hold the leaves in place, we use coarse wire netting and lath screens. A load or two of coarse marsh hay, consisting mostly of sedges, constitutes the chief material for mulch during winter. It is cheap, tough, dingy in color, so that a few straws left on the ground in spring are much less conspicuous and objectionable than straw of wheat, rye, or oats.

Much to my regret, owing to partial failure of the artesian wells to supply all the numerous demands of our increased population, we have been compelled to resort to the use of river water to keep the ponds and bogs well supplied. This water, as you know, during a portion of the spring, is almost as dark as coffee.

To keep in check the water-snails, worms and insects and to prevent the multiplication of mosquitoes, a few sun-fish have been kept in the ponds, and they do their work most effectually. From early August to late October, we usually trap about a dozen muskrats, which show no respect for our tenderest and choicest aquatics. Red squirrels and chipmonks receive the same kind of attention as the muskrats, for they are very mischievious. Ground moles are annoying and our efforts to exterminate them usually avail little. This year we used in their runways perhaps ten pounds of pulverized condensed lye, with little evidence that it reduced the number. There are not a few other annoyances to contend with, such as surface water from the sloping banks and quantities of earth from the banks of the roadway passing across the brook above the garden, this earth covering our plants and choking the brook.

The worst weeds in the garden are quackgrass in a few of the newer portions, and seeds of plants that we grow in some of the plots, including annual spear grass, narrow-leaved dock, and a few others introduced with the compost. Ten or twelve years ago, I introduced into the deeper pond an aquatic from the South, a plant allied to thc water lilies, and known as Caboba Caroliniana. It thrives and spreads rapidly. It is fished out with hoe, rake, and dip-net, but small fragments of stems break off, float about, take root, thrive, and multiply. To kill quack grass on a sloping bank of the brook, where cultivation is impracticable, three years ago, I used two barrels of salt on an area about four rods long. This cost too much and took too long. This year, at a trifling cost, I spread tarred building paper closely over another portion of a bank of the brook, killing quack grass with perfect success.

To keep all plants plainly and correctly labelled is no small task. At different times, I have in turn, adopted the style of labels of the two oldest gardens in this country, to soon abandon both for something different. Both of the gardens referred to have made a number of changes in style of labels. For a few years now, the label used may be described as follows: A straight piece of iron one-eighth by three-fourths of an inch in section and eighteen inches long; across the top is riveted a piece of thick sheet steel two and a half by four inches, when the whole is galvanized. For some reason, the names painted on these labels, vary much in dura-

bility, from a year to five years. Possibly the rapid failure of some lettering may be due to the presence of a little acid left in the galvanizing process. Sets of labels were lettered with coach or carriage paint, Eureka bicycle enamel, and lampblack. mixed with boiled linseed oil. The last kind of paint here named was the most enduring. Another test was made by placing a thin coat of paraffin over the label after it had been lettered. to find, after a year or more, some of the paraffin scaled off, some blackened by fungus. Another test was made by coating a label with spar varnish, to find in a year or two, the varnish cracking off. Still another test was made by placing two very thin coats of boiled linseed oil over the label, the first coat being well dried before applying the second. Of all the tests made, labels painted with lampblack and boiled linseed oil and then covered with two coats of this oil, were the most satisfactory.

Very few persons pay any attention to the labels by the plants, but some complain if everything is not labelled. In most cases the common name appears with the scientific name, if the plant has any common name of any definite significance. Plants are usually arranged by families, as before mentioned, and a tall, general label is placed in each bed. These general labels or family labels set forth the uses of some of the plants with their common names.

I am making a few inexpensive experiments, one of which is a test of seedlings of a number of peculiar plants of Rudbeckia hirta L., often known as Black-Eyed Susan. The ray flowers of one plant in some instances were six inches from tip to tip on the head.

Considerable pains is taken to transplant from outside the garden anything that shows some marked peculiarity, especially when it is more ornamental than the ordinary plants of the species. I have twelve of the best varieties of Timothy, obtained of Prof. A. D. Hopkins, formerly connected with the Experiment Station of West Virginia. One of these varieties flowers as early as early red clover, but lacks vigor and size. For three years I have grown seedlings from the strongest of the early plants, weeding out the weakest from time to time. I now have a hundred of the strongest of the last generation, from which I shall select, at time of flowering next May or June. In like manner, I am selecting and testing nine sorts of orchard grass, four of meadow foxtail, three of sweet vernal. Some of these tests should be of value to the farmer and horticulturist of this state. They are certainly of interest to all who see and understand them, especially so to the director of the garden.

PLANTS AND OTHER FEATURES MOST ADMIRED.

First must be included the pink water-lily and perhaps the large white European water-lily, and, in season, the wild rice in the pond, where it grows to twelve feet high.

In early spring, the crocus, hyacinths, tulips, harbinger of spring, hepaticas, spring beauty, trillium, adder tongues, squirrel corn, Dutchman's breeches, willows, and the young growth of large numbers of shrubs, such as lilacs, honey-suckles, spiraeas, and young ferns, not omitting the green grass of the paths, which is bright because it had been closely mowed the previous year.

In general, everything considered, the garden is most attractive in July and August. It seems a great pity that our students in botany cannot be

in attendance during the summer to avail themselves of what may be learned from the garden at that time. Early June is the time for roses and grasses, lilacs, and spiraeas.

On July 15th, I took notes of plants of most interest to visitors at that time. The list may interest a few: Crimson wild bergamot, lasting nearly two months, foxglove, large blue clematis, red and white hollyhocks, ferns, young mixed growth on the banks of the brook, several kinds of foreign mulleins, two or three sages, one kind of catnip, hyssop, a group of sumachs, a bed of mixed poppies, several chrysanthemums, loosestrife, wild peas, hydrangeas.

On August 4th were the following: Crimson wild bergamot, a patch of cardinal flower, a number of mints, Rocky-mountain bee plant or Cleome, if you are not afraid of scientific names, Bocconia, several wild sun-flowers, and rosin weeds, black-eyed Susans and their cousins.

On August 20th, the following were noted: Cardinal flowers, several kinds of Hibiscus, four-o'clocks, scarlet-runner beans, Tamarix, wild indigo, Hercules' club, spikenard, snow-on-the-mountain, castor bean, button snake-roots, several kinds of Clematis and Statice, Cleome, teasels, four or five kinds of flax, dodder, Indian corn, Arundo, Celosia, hydrangeas, zinnias, balsams, cat-tail flags, especially the species with narrow leaves, and a large number of plants of the aster or sun-flower family.

On September 20th, were the following: The green tops of many things that endured frost, purple barberry, Clematis paniculata, wild asters by the brook, Hibiscus, Meibomia pendulifolium, scarlet-runner pea, Pitcher's sage, broad-leaved pea, Asperula setosa, sumachs, castor bean, two kinds of Martynias, ten-weeks' stock, Kochia or World's Fair Beauty, Arundo, Pennisetum, Eulalia zebrina, prince's feather, Petunia, three Boltonias, Rudbeckia trifolia, Helianthus orgyalis, H. multiflorus, H. Kellermanii, China asters, three kinds of poke weed, long flowered tobacco.

On October 29, after severe frosts, were the following: Four kinds of Tamarix, rue, cacti, broad-leaved pea, Potentilla tridentata, house-leeks, bear berry, periwinkle, Geum, Sanguisorba, Indian strawberry, prairie rose, Rosa lucida, R. Witchuriana, R. spinosissima, Kerria Japonica, Rubus xanthocarpa, Ajuga reptans, Genista tinctoria, Stachys lanatus, Astralagus maximus, Mentha crispa, thyme, Origanum, gill-over-the-ground, green briars, asparagus, five kinds of yucca, Ampelopsis arborea, Torrey's Pentstemon, Symphoricarpos pauciflorus, Lonicera Morrowi, L. Japonica, L. Standishii, L. Halleana. Viburnum plicatum, V. dentatum, V. Lantana, V. molle, V. prunifolium, ten or more kinds of barberries, two phloxes, evergreen ferns, such as Dryopteris marginale, D. Filix-mas, D. aculeatum, D. acrostichoides, Polypodium vulgare, Scolopendrium, hepaticas, green hellebore, ground hemlock, sweet fern, a dozen kinds of Iris, swamp blueberry, Acanthus spinosus, Polygonum dumetorum, mignonette, daisy of Europe, pansies, several kinds of privet, purple oxalis, Alyssum Wierzbackii, Erysimum rupestre, a dozen sorts of Dianthus for foliage, Arenaria graminifolia, Cerastium arvense, Geranium sanguincum, Saxifrage cordata, S. crassifolia, horned poppy, Rhus Canadensis, Euonymus obovatus, two St. Johnsworts, Anchusa officinalis, three wild Senecios, milk thistle, two species of Acanthus, eleven cudweeds in variety, Coreopsis delphinifolia, C. tripteris, Aster multiflorus, Rudbeckia trilobata, golden pyrethrum, Scandix, Heracleum asperum, furze, Psoralea Onobrychis, and a great many more almost as good.

In the garden we grow only one plant or a bunch of one thing, which is labelled and in this way much less confusing than to view scattered about ten to fifty plants of one species or variety.

This season, I chanced to meet, as strangers to me, two men, one from Lansing, one from Mason, who told me they visited the garden at least once a month because it was a pleasure to them and because they wished to make the acquaintance of desirable plants that they might grow them about their homes.

Below are enumerated a few expressions that were gathered by three persons, who overheard remarks made by visitors while in the garden: "Oh, the lovely pink water-lilies!" "Isn't this old log cabin cunning?" "I think this is just the loveliest place." "No use talking, this is a very interesting place." "Just beautiful." "Isn't this pretty?" "This is the prettiest place I ever saw." "Here is another plant I don't know." "This garden is the dearest little spot!" "It is certainly lovely." "What a beautiful place!" "These grass walks are so nice to walk on!" "Oh, here are some pink water-lilies, the first I ever saw. How sweet!" "How fine and large these white water-lilies are!" [referring to the large white lilies from Europe.] "One can find everything in this garden." "See the grass walks!" "My, but this is a swell place!" "Oh, what a pretty poppy bed!" "Aren't these grass-walks fine!" "How clean and trim everything is kept here!" "The little log cabin in the garden!" "I would like to live here." "Ain't them nice!" "How lovely these ferns are!" "If you want to see a pretty place just go down into the botanic garden." "They ought to be prosecuted for letting these thistles go to seed," [supposing they were Canada thistles, which they were not.] "I wonder if there is anything they haven't got here." "Look at the pond lilies! Here are some pink ones!" "The pretty poppies!" "Them labels are jaw-breakers, ain't they?" "The little log cabin!" "What a delightful place this is!" "Just see these old-fashioned daisies!" "Them pink lilies are just like wax." "I wish I could spend a week here." Visitor to gardener: "What are you making?" Gardener: "A rustic bridge." Visitor: "I guess it will be rusty, all right." "Oh, Dr. Beal; I have found you at last! I want to thank you for planting this beautiful garden." "I have never seen anything like it, either in the United States or Europe." "I can truly say that I have been struck speechless at the sight of plants so foreign to this country." "Isn't this a lovely view? I believe these benches were placed right where we could get the best views of the garden." "I didn't know that there were so many kinds of timothy and orchard grass." "Is that the way you start these grass walks? I never thought of that before." [Referring to small bits of sod scattered over the place and then rammed down.] "This little garden looks as if it would keep one man busy most of the time." "Come around this way and see the ferns; they are lovely." "Look here, they are raising mulleins! I wonder if that is educational?" "My, those morning-glories are fine. I wish I could pick some seeds." "Say, Mister, is this bridge safe?"

B. T. Galloway, Chief of the Bureau of Plant Industry at Washington, after spending a half-day in the garden, said: "I want something as nearly like this as I can make it, only larger."

During four months or more of the year, this plot of two acres attracts more visitors than any other one thing or department of the college.

THE NEW ARTESIAN WELL.

As previously intimated, there has for many years often been trouble in securing a perpetual supply of good water for keeping the ponds full and the bogs in good condition; besides, the engineer was annoyed in coming to our aid every little while to remedy the evil, if it were possible to do so.

Very much to my satisfaction, during April of this year, the State Board employed Packard & Edgerton to drive a three-inch well with galvanized iron pipe into the rock below. The whole depth from the surface of the upper pond was 177 feet and 4 inches. The water will rise in the pipe a little over five feet. The supply is abundant and satisfactory.

THE JUNE FRESHET.

Twenty-four hours preceding the morning of June 6th, 5.82 inches of rain had fallen, causing the highest water during the growing season of any in at least thirty-five years. When the snow and ice melted the year previous, the water rose in the botanic garden from four to five inches higher than it did this year. A heavy freshet when plants are resting in cold weather does little if any harm, but many plants succumb when they are submerged for three or four days during the growing season. A large proportion of the garden was from a foot to two feet under water for over three days. Some damage was done by strong currents of water. Nearly all plants were checked in growth and were left in forlorn condition, sprawling on the ground and covered with dingy sediment. Of the 2,200 kinds of plants, 243 were killed, saying nothing about a large number that were nearly killed, and many more that were rendered unsightly by the prolonged application of muddy water. The aquatics were not injured. It was interesting to note that the leaf-stalks of Potamogeton natans during the days of the high water had increased their length eight to twelve inches, and the stems of white water lilies had elongated twenty to thirty inches, all in the attempt to keep the leaf-blades and flowers at the surface of the water.

Before the high water had retreated, plans were already made to prevent a recurrence of another disaster of this kind. The scheme is, briefly, to plant on low land nothing that will not endure a summer overflow, and to raise all other land, if not already high enough, to high water mark or above it.

THE HERBARIUM.

* The additions that have been mounted and installed during the year past are here enumerated:

SEED PLANTS, FERNS, AND THEIR ALLIES.

Elias Nelson, Species of Antenaria	13	
Home Collections	143	
		156

*Collections still on hand and not installed nor yet reported in inventory (about 2,500) to appear in next report.

FUNGI.

W. A. Kellerman, Ohio, Fascicles 161-200	40	
E. Bartholomew, Fungi Columbiana, Century 20	100	
Seymour & Earle, edited by G. P. Clinton	50	
Fleshy Fungi, Michigan	100	
Remains of the Hicks Collection	800	
		1,090

ALGAE.

F. S. Collins, Fascicles XXV	50
Total additions for the year	1,296

GENERAL SUMMARY OF PLANTS IN THE HERBARIUM.

Seed Plants, Ferns and Their Allies	67,116	
Mosses and Liverworts	1,974	
Lichens	1,186	
Fungi, Home Collections	16,843	
Algae	2,070	
Total		89,189

DONATIONS TO THE BOTANICAL DEPARTMENT.

From C. F. Wheeler, Washignton, D. C., 13 Antenaria, distributed by Elias Nelson, Laramie, Wyoming.

From H. C. Skeels, Joliet, Ill., 29 kinds of living plants.

From John M. Dye, Lansing, Mich., 1 pkt. Heath Seed; 1 pkt. Dwarf Furze.

From U. S. Department of Agriculture, 10 Fiber Plants.

From B. O. Longyear, Fort Collins, Colo., Seeds of Mentzetia nuda; plants of Euphorbia marginata, Artemisia frigida.

From Mrs. Helen W. Paul, Ontonagon, Mich., Plants of Moneses grandiflora, Mitchella repens alba.

From Charles E. Barnes, Battle Creek, Mich., Plants of Cypripedium candidum.

From L. L. Kelley, Lansing, Plants of Cypripedium spectobile.

GIFTS TO OTHERS.

To State Normal College 200 lots of weed seeds.

To Alma College, 144 lots of weed seeds.

To Miss Alta B. Chase, for the Monroe schools, 144 lots of weed seeds.

W. J. BEAL,
Professor of Botany.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF ENGLISH AND MODERN LANGUAGES.

To the President:

The work of the Department of English and Modern Languages for the year just closed has not differed materially from that of the year previous. My report for that year (1903-1904) was quite elaborate and detailed, and I have deemed it sufficient, therefore, merely to refer to my former report for information concerning the nature and extent of the work.

The main point of difference lies in the steady increase in the registration of all the classes, necessitating a further sectioning of the German classes and the English of the sophomore year. This division has, in turn, compelled the employment of another teacher in place of the essay-reader previously kept at work, and has also forced us to lessen the amount of written work required of the student. The change has increased the expense of the department by about $200. The decrease of the written work is, I am sure, something to be greatly deplored.

With the increased enrollment in the classes in literature comes the necessity for duplicating and multiplying our resources for reference work in the library. The work in these classes is carried on by inductive study of the masterpieces of literature, with subsequent reference to standard criticism for confirmation and correction of the conclusions independently reached. It is not feasible to ask classes of fifty or more students to prepare reference work from the single copy of an author accessible in the library, and it rarely happens that a body of really valuable criticism sufficient for distribution to such a class is available.

To obviate the difficulty, I suggest that we begin to create a department library consisting of an adequate number of copies of carefully chosen books bearing upon the courses to be given. I respectfully recommend that the sum of one hundred dollars be placed at my disposal for the purpose mentioned.

The work of this department is distributed over the whole four years of the courses in portions ranging from one hour to five hours per week per term for each student. It is thus impossible, without a somewhat elaborate system of records, to keep track of all details of each student's progress. These records are in existence, but the department lacks adequate and necessary conveniences for filing them. I respectfully request that the department be provided with a suitable filing cabinet, and that it be given a part of the time of a clerk at stated intervals, for the purpose of entering grades and remarks on the records mentioned.

Respectfully submitted,

HOWARD EDWARDS,

Professor of English and Modern Languages.

Agricultural College, Michigan, June 30, 1905.

REPORT OF THE DEPARTMENT OF MATHEMATICS AND CIVIL ENGINEERING.

To the President:

Sir—The year just past is entitled to record as one of fairly satisfactory results and marked by an efficiency out of proportion to our provisions for the work. This means that although the arrangement of class-rooms has not been improved since my last annual report, and although a number of other recommendations have not yet been acted upon, there is no distinct item of failure to be directly traced to what we lack in facilities. Harmony in the department, good fortune in securing teachers who are able to interpret and carry on their work as demanded by our courses, and an exceptionally industrious spirit of endeavor among the members of our classes, have all conspired favorably.

The above should not be taken as in any sense lessening our needs. The recommendations of my last annual report might be more strongly urged in this one, and a re-reading of that report is respectfully suggested.

At the beginning of the college year the staff of teachers in the department included the following: Assistant Professor W. Babcock and Instructors R. Hopkins, G. W. Hartwell, A. E. Jones, C. Gundersen, F. E. Mills, and G. G. Sweet. On November 15, Mr. Sweet resigned, and Mr. A. R. Alger was appointed instructor in his stead. After this date the personnel of the department remained without change to the end of the year. Without exception, these men have labored faithfully for the welfare of the department, and are entitled to all the credit which attaches to efficient well-directed teaching. Instructor R. Hopkins has resigned to engage in similar work at Cornell. Instructor Hartwell has received a scholarship at Columbia University, and will spend next year in study at that institution.

As usual, a table has been prepared in which is shown the class work of the department, the assignments of instructors, and other information which might be called in question. An examination of the table and a comparison with similar ones for earlier years will show that we have dealt with a larger number of students than ever before, that we have met a larger number of sections in every term, but that the average number in a section has been smaller.

Class work of the department of mathematics and civil engineering for the college year 1904-05.

Class.	Subject.	Number of course.	Teacher.	Class-room.	Hour of meeting.	No hours per week.	No. of students in class.
Fall term:							
Sub-freshmen	M. algebra	Math. 1c	Mr. Alger	Dairy	8-9	5	25
Sub-freshmen	M. algebra	Math. 1c	Mr. Alger	Dairy	9-10	5	23
Sub-freshmen	M. algebra	Math. 1c	Dr. Gundersen	Abbot Hall	9-10	5	25
Sub-freshmen	M. algebra	Math. 1c	Dr. Gundersen	6, College Hall	2-3	5	25
Sub-freshmen	Ag. & W. algebra	Math. 1	Mr. Jones	8, College Hall	8-9	5	29
Sub-freshmen	Ag. & W. algebra	Math. 1	Mr. Jones	8, College Hall	9-10	5	28
Sub-freshmen	Ag. & W. algebra	Math. 1	Mr. Hartwell	Dairy	10-11	5	14
Sub-freshmen	Ag. & W. algebra	Math. 1	Mr. Hartwell	Dairy	11-12	5	18
Freshmen	M. algebra	Math. 1e	Mr. Hopkins	6, College Hall	9-10	5	18
Freshmen	M. algebra	Math. 1e	Mr. Hopkins	Bot. Bldg	10-11	5	32
Freshmen	M. algebra	Math. 1e	Mr. Jones	8, College Hall	10-11	5	18
Freshmen	M. algebra	Math. 1e	Prof. Babcock	6, College Hall	1-2	5	21
Freshmen	M. algebra	Math. 1e	Mr. Hartwell	Abbot Hall	2-3	5	30
Freshmen	Ag. algebra	Math. 1b	Mr. Alger	Dairy	10-11	5	30
Freshmen	Ag. algebra	Math. 1b	Prof. Babcock	6, College Hall	3-4	5	36
Freshmen	Ag. & W. algebra	Math. 1b	Mr. Jones	8, College Hall	1-2	5	25
Freshmen	W. algebra	Math. 1b	Dr. Gundersen	8, College Hall	3-4	5	32
Freshmen	M. geom	Math. 2d	Mr. Hartwell	Dairy	8-9	5	25
Freshmen	M. geom	Math. 2d	Mr. Hartwell	Abbot Hall	1-2	5	18
Freshmen	M. geom	Math. 2d	Mr. Mills	2, College Hall	11-12	5	28
Freshmen	M. geom	Math. 2d	Mr. Alger	Dairy	11-12	5	20
Freshmen	M. geom	Math. 2d	Mr. Jones	Dairy	1-2	5	30
Sophomores	Analytic geom	Math. 5	Prof. Babcock	6, College Hall	8-9	5	24
Sophomores	Analytic geom	Math. 5	Prof. Babcock	6, College Hall	10-11	5	24
Sophomores	Analytic geom	Math. 5	Dr. Gundersen	Abbot Hall	8-9	5	24
Sophomores	Analytic geom	Math. 5	Dr. Gundersen	Abbot Hall	10-11	5	22
Juniors	Mech. of eng	Math. 7a	Prof. Babcock	6, College Hall	11-12	5	24
Juniors	Mech. of eng	Math. 7a	Mr. Hopkins	8, College Hall	11-12	5	22
Juniors	Surveying (class)	Civ. eng. 1b	Mr. Mills	2, College Hall	10-11	2	25
Juniors	Surveying (class)	Civ. eng. 1b	Mr. Mills	2, College Hall	10-11	2	32
Juniors	Surveying (field)	Civ. eng. 1b	Prof. Vedder, Mr. Mills and Mr. Alger.		1-3	2	20
Juniors	Surveying (field)	Civ. eng. 1b	Prof. Vedder, Mr. Mills and Mr. Alger.		1-3	2	37
Seniors	Ag. Civ. eng. (class)	Civ. eng. 2	Prof. Vedder	2, College Hall	9-10	5	1
Seniors	Ag. Civ. eng. (field)	Civ. eng. 2	Prof. Vedder		1-3	2	1
Seniors	Graphics	Civ. eng. 4	Mr. Mills	2, College Hall	8-9	3	28
Seniors	R. R. Surveying	Civ. eng. 7	Mr. Hopkins, Mr. Mills.	2, College Hall	1-4	6	19
Seniors	Br. Stresses	Civ. eng. 8a	Prof. Vedder	2, College Hall and basement	10-11	3	16
Totals	39 sections					167	860

Class work.—Continued.

Class.	Subject.	Number of course.	Teacher.	Class-room.	Hour of meeting.	No. hours per week.	No. of students in class.
Winter term:							
Sub-freshmen....	Ag. & W. algebra.....	Math. 1a......	Mr. Hartwell......	Basement, C. H...	11–12	5	20
Sub-freshmen....	Ag. & W. algebra.....	Math. 1a......	Mr. Mills.........	2, College Hall....	10–11	5	20
Sub-freshmen....	Ag. & W. algebra.....	Math. 1a.....	Mr. Alger.........	8, College Hall....	8–9	5	19
Sub-freshmen....	Ag. & W. algebra.....	Math. 1a.....	Mr. Alger.........	8, College Hall....	9–10	5	11
Sub-freshmen....	M. algebra...........	Math. 1d.....	Mr. Hopkins......	Basement, C. H...	10–11	5	20
Sub-freshmen....	M. algebra...........	Math. 1d.....	Mr. Jones.........	8, College Hall....	2–3	5	20
Sub-freshmen....	M. algebra...........	Math. 1d.....	Mr. Alger.........	Dairy............	2–3	5	22
Sub-freshmen....	M. algebra...........	Math. 1d.....	Mr. Alger.........	8, College Hall....	10–11	5	19
Freshmen.......	Ag. geom.............	Math. 2b.....	Mr. Hopkins......	Basement, C. H...	9–10	5	18
Freshmen.......	Ag. geom.............	Math. 2b.....	Mr. Mills.........	Basement, C. H...	2–3	5	19
Freshmen.......	Ag. geom.............	Math. 2b.....	Mr. Jones.........	Abbot Hall.......	9–10	5	18
Freshmen.......	W. geom..............	Math. 2b.....	Mr. Mills.........	6, College Hall....	8–9	5	23
Freshmen.......	W. geom..............	Math. 2b.....	Mr. Hartwell......	Basement, C. H...	3–4	5	19
Freshmen:......	M. algebra...........	Math. 1f......	Prof. Babcock.....	6, College Hall....	11–12	5	17
Freshmen.......	M. algebra...........	Math. 1f......	Mr. Jones.........	8, College Hall....	11–12	5	17
Freshmen.......	M. algebra...........	Math. 1f......	Mr. Jones.........	Abbot Hall.......	1–2	5	15
Freshmen.......	M. algebra...........	Math. 1f......	Mr. Hartwell......	Basement, C. H...	1–2	5	17
Freshmen.......	M. algebra...........	Math. 1f......	Mr. Mills.........	Abbot Hall.......	11–12	5	20
Freshmen.......	M. algebra...........	Math. 1f......	Dr. Gundersen....	8, College Hall....	1–2	5	16
Sophomores.....	M. & W. Dif. Cal.....	Math. 6a.....	Prof. Babcock.....	6, College Hall....	10–11	5	21
Sophomores.....	M. Dif Cal...........	Math. 6a.....	Dr. Gundersen....	Abbot Hall.......	10–11	5	15
Sophomores.....	M. Dif. Cal...........	Math. 6a.....	Dr. Gundersen....	8, College Hall....	2–3	5	17
Sophomores.....	M. Dif. Cal...........	Math. 6a.....	Dr. Gundersen....	8, College Hall....	3–4	5	17
Sophomores.....	M. Dif. Cal...........	Math. 6a.....	Mr. Hartwell......	6, College Hall....	2–3	5	17
Juniors..........	Mechanics............	Math. 7b.....	Prof. Babcock.....	6, College Hall....	9–10	5	24
Juniors..........	Mechanics............	Math. 7b.....	Prof. Babcock......	6, College Hall....	1–2	5	22
Seniors..........	Ag. Eng'g............	Civ. eng. 3...	Prof. Vedder......	Office............	10–11	5	1
Seniors..........	Bridge design.........	Civ. eng. 8b..	Prof. Vedder......	2, College Hall....	8–10	8	15
Seniors..........	Hydraulics (class).....	Civ. eng. 5...	Mr. Hopkins......	2, College Hall....	11–12	5	16
Seniors..........	Hydraulics (lab.)......	Civ. eng. 5....	Mr. Hopkins......	2, College Hall....	1–3	4	16
Totals......	30 sections...........	....	....	....	....	152	548

Class work.—Concluded.

Class.	Subject.	Number of course.	Teacher.	Class-room.	Hour of meeting.	No. hours per week.	No. students in class.
Spring term:							
Sub-freshmen....	Ag. & W. geom.......	Math. 2a.....	Mr. Mills..........	8, College Hall....	9-10	5	26
Sub-freshmen....	Ag. & W. geom.......	Math. 2a.....	Mr. Alger..........	8, College Hall....	8-9	5	21
Sub-freshmen....	Ag. & W. geom.......	Math. 2a	Mr. Hartwell......	Basement, C. H...	2-3	5	23
Sub-freshmen....	M. geom.............	Math. 2c.....	Mr. Alger..........	Dairy............	11-12	5	16
Sub-freshmen....	M. geom.............	Math. 2c.....	Mr. Jones..........	Dairy............	11-12	5	18
Sub-freshmen....	M. geom.............	Math..2c.....	Mr. Hartwell......	8, College Hall....	11-12	5	17
Sub-freshmen....	M. geom.............	Math. 2c.....	Dr. Gundersen....	8, College Hall....	2-3	5	17
Sub-freshmen....	Mensuration..........	Math. 3......	Mr. Alger..........	Dairy............	10-11	5	19
Sub-freshmen....	Mensuration..........	Math. 3......	Mr. Jones..........	Dairy............	10-11	5	17
Sub-freshmen....	Mensuration..........	Math. 3......	Mr. Jones..........	6, College Hall....	1-2	5	13
Sub-freshmen....	Mensuration..........	Math. 3......	Mr. Hartwell......	Basement, C. H...	1-2	5	19
Freshmen.......	Ag. & W. Trig.........	Math. 4a.....	Mr. Mills..........	2, College Hall....	8-9	3	23
Freshmen.......	Ag. & W. Trig.........	Math. 4a.....	Mr. Mills..........	2, College Hall....	10-11	3	21
Freshmen.......	Ag. & W. Trig.........	Math. 4a.....	Mr. Hopkins......	Basement, C. H...	8-9	3	32
Freshmen.......	M. Trig..............	Math. 4b.....	Dr. Gundersen....	Abbot Hall.......	9-10	5	24
Freshmen.......	M. Trig..............	Math. 4b.....	Dr. Gundersen.....	8, College Hall....	1-2	5	14
Freshmen.......	M. Trig..............	Math. 4b.....	Prof. Babcock.....	6, College Hall....	11-12	5	24
Freshmen.......	M. Trig..............	Math. 4b.....	Mr. Jones..........	6, College Hall....	2-3-4	5	22
Freshmen.......	Ag. Surv'g (class).....	Civ. eng. 1a..	Mr. Mills..........	2, College Hall....	8-9	2	25
Freshmen.......	Ag. Surv'g (class).....	Civ. eng. 1a..	Mr. Mills..........	2, College Hall....	10-11	2	31
Freshmen.......	Ag. Surv'g (field).....	Civ. eng. 1a..	Prof. Babcock, Mr. Mills and Mr. Alger.	2, College Hall....	1-3	2	25
Freshmen.......	Ag. Surv'g (field).....	Civ. eng. 1a..	Prof. Babcock, Mr. Mills and Mr. Alger.	2, College Hall....	1-3	2	31
Sophomores.....	Integ. calculus.........	Math. 6b.....	Prof. Babcock.....	6, College Hall....	8-9	5	19
Sophomores.....	Integ. calculus.........	Math. 6b.....	Prof. Babcock.....	6, College Hall....	9-10	5	22
Sophomores.....	Integ. calculus	Math. 6b.....	Dr. Gundersen....	Abbot Hall.......	11-12	5	14
Sophomores.....	Integ. calculus.........	Math. 6b.....	Mr. Hartwell......	8, College Hall....	10-11	5	17
Juniors.........	Dif. equations.........	Math. 8......	Prof. Babcock.....	6, College Hall....	10-11	2	23
Juniors.........	Dif. equations	Math. 8......	Dr. Gundersen....	Abbot Hall.......	10-11	2	28
Juniors.........	H. Surv'g (class)......	Civ. eng. 6...	Prof. Vedder......	2, College Hall....	9-10	3	37
Juniors.........	H. Surv'g (field)	Civ. eng. 6...	Prof. Vedder, Mr. Mills and Mr. Hopkins.	2, College Hall....	1-4	6	37
Seniors..........	H. Surv'g (class)......	Civ. eng. 6...	Prof. Vedder... ..	2, College Hall....	9-10	3	9
Seniors..........	H. Surv'g (field).......	Civ. eng. 6...	Prof. Vedder, Mr. Mills and Mr. Hopkins.	2, College Hall....	1-4	6	9
Seniors..........	Masonry and arches...	Civ. eng. 9...	Mr. Hopkins......	Basement, C. H...	10-12	8	15
Seniors..........	Pavements............	Civ. eng. 10..	Prof. Vedder......	2, College Hall....	9-10	2	28
Seniors..........	Thesis...............	Civ. eng. 11..	Prof. Vedder, Mr. Hopkins.	2, College Hall....	1-5	12	7
Totals......	35 sections...........	....	....	....	....	156	739
Grand totals.	104 sections..........	....	....	....	....	475	2,156

The following text-books have been used in our classes during the year: Beman & Smith's Higher Arithmetic for classes in mensuration; Beman & Smith's Academic Algebra for all beginning classes formed by women and agricultural students; Van Velzer & Slichter's University Algebra for all engineering students; Wentworth's Geometry; Ashton & Marsh's Trigonometry; Tanner & Allen's Analytic Geometry; Taylor's Calculus; Hodgman's Surveying; Johnson's Surveying for all classes in higher surveying; Church's Mechanics; Merriman & Jacoby's Graphic Statics; Merriman & Jacoby's Bridge Stresses: Merriman & Jacoby's Bridge Design; Allen's Railroad Curves and Earthwork; Baker's Masonry Construction; Murray's Differential Calculus; Baker's Roads and Pavements.

The total expenditure by the department during the year for all purposes has been $2,020.46, of which $95 was turned in for special examinations.

Respectfully submitted,
H. K. VEDDER,
Professor of Mathematics and Civil Engineering.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF PHYSICS AND ELECTRICAL ENGINEERING.

To President J. L. Snyder, Agricultural College Michigan:

Dear Sir—I have the honor of submitting herewith the following report of the year's work in this department. Through the generous action of the board we have been able to add materially to the equipment of the department, also two additional rooms in the basement of College Hall were fitted up and placed at the disposal of the department. One as a recitation room and the other as a laboratory where the Sub-Freshmen work was carried on during the year. We feel that we have made many improvements over the conditions last year and have not been quite so crowded as last year, yet we are looking forward to more permanent quarters as soon as they can be provided. We believe the instruction has been very efficient both in the recitation room and in the laboratory. We propose, however, to put the laboratory work on a different basis for the coming year which will enable us to use the present laboratory rooms more hours in the day and thus give the effect of having more room. There is a considerable demand on the part of the students for more instruction in electricity, not necessarily Electrical Engineering, and if two more rooms can be fitted up during the summer in the basement of College Hall it will enable us to meet that demand without increasing the amount of apparatus materially.

Total number of students enrolled in the classes for the past year has been 751 as against 723 last year and 429, 1902-3.

Yours very truly,
A. R. SAWYER,
Professor of Physics and Electrical Engineering.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF HISTORY AND POLITICAL ECONOMY.

To the President:

It gives me pleasure to submit the following report of the work done in the Department of History and Economics during the school year 1904-05. The total number of enrollments of students in this department during the year was 575, distributed as follows:

By terms—Autumn, 150; winter, 165; spring, 260.

By classes—Sub-freshmen, 110; sophomores, 230; juniors, 150; seniors, 98.

By subjects—History, 275; political science, 130; political economy, 130.

The total number of hours taught was 986, divided among the three terms as follows: Autumn, 24 per week; winter 25 and spring 34. Whole number of classes conducted throughout the year, 18—averaging six per term.

While this number of hours is unequally distributed among the terms of the year—as may be easily inferred from a comparison of the hours in the spring term with those of the autumn—rather to the embarassment of the department, it is hoped an opportunity, that transfers of subjects may be made with other departments conducive to greater equality.

It still remains—as was noted last year—that one of the greatest hindrances to efficient work in this department is the lack of a permanent class room. More classes are being taught than in former years and each increase of the work augments the confusion of moving about from class room to class room.

I cheerfully commend again the efforts of Mrs. Hendricks, who has been my assistant for another year. Her painstaking industry and teaching ability have done much toward enhancing the worth of this department.

Very respectfully,

WILBUR O. HEDRICK,

Ass't Professor of History and Political Economy.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF DRAWING.

To the President:

Dear Sir—As you have been informed in detail each term of the number of classes, students, subjects, etc., assigned to each instructor in the department it seems unnecessary here to repeat such report. It is sufficient to say that every one in the department has been busy during the year.

Arthur E. Palmer, a graduate of Pratt Institute, in the department of science and technology, has been added to our force and has proved himself an earnest and efficient instructor.

At the risk of being compared with the hypochondriac I wish to say that the crowded condition of our class rooms grows more serious each year. It could not very well be worse, "still, I don't complain."

The lighting of two drawing rooms has been somewhat improved by the installation of some small arc lamps. Aside from this there has been no material addition to the equipment.

A new subject has been added to the work carried by the department. The elective in Horticulture of the spring term, senior year (Hort. 10), involves training in drawing, designed as a part of the preparation for landscape architecture. This is in charge of Mr. Newman, and the initial work has been quite successful.

In general our work has been fairly satisfactory, but in one instance the quality of the work done was noticeably inferior to that of previous classes. This was due apparently to the overloading of the course at that point. It is very desirable that this condition be changed if possible.

A very decided improvement in the matter of filling orders for drawing outfits has been inaugurated by the College Co-operative Bookstore. By placing with one firm an order for pretty nearly the full number of outfits used a very material reduction in price has been secured. The work of supply was never before carried out with so little trouble to all concerned, and with such uniformly satisfactory results.

Respectfully submitted,

W. S. HOLDSWORTH,

Professor of Drawing.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF BACTERIOLOGY AND HYGIENE.

To President J. L. Snyder:

The year which is just closing has been the most successful in the history of this department, both in respect to what has been actually done and what has been projected. These satisfactory conditions may be attributed to added assistance, to adjustment in our new quarters, and to enlarged facilities.

Our class work may be summed up as follows:

Subject.	Number of students.	Totals.
Fall term:		
Bacteriology 1, lectures	34	
Bacteriology 2, laboratory	45	
Hygiene 7, lectures	107	
Emergencies 8, lectures	48	
Total	....	234
Winter term:		
Bacteriology 3, laboratory	34	
Bacteriology 2, laboratory	24	
Bacteriology 3, lectures	34	
Bacteriology 2, lectures	24	
Total	....	116
Winter term, short courses:		
Creamery, lectures	52	
Creamery, laboratory	32	
Live stock, lectures	67	
Cheese, lectures	25	
Cheese, laboratory	7	
Total	....	183
Spring term:		
Bacteriology 4	32	
Sanitary science 7, men	11	
Sanitary science 7, women	22	
Total	....	65
Special students	....	2
Grand total	....	600

It may also be pertinent for me, even in this report, to refer to the work of the college hospital, so carefully and capably conducted by Miss Ketchum. With nearly one thousand students, housed largely in dormitories, it is an ever recurring gratification to know that there is some place where the sick may be nursed properly at small expense. This year has been marked by few contagious diseases and yet there have been registered in the hospital, as patients who have remained there for an average period of six and one-half days, sixty-nine students. Fully as many more have called there for care. It has become a rendezvous or home for the ailing and has fulfilled its mission most pleasingly and satisfactorily. Without it, contagious diseases could not be readily controlled or the sick properly cared for; even

with it the dangers from without are growing on account of the rapid settlement of adjacent territory with inadequate sanitary control.

No greater privilege is mine than to testify to the efficient services of Messrs. Sackett, Wright, Clark, and Dr. Wetmore in carrying forward the work of instruction offered by this department. They have not only shown an active interest, but have carried into their work "the will to do" and deserve the credit for what they have accomplished.

Very respectfully submitted,

CHARLES E. MARSHALL,

Professor of Bacteriology and Hygiene.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF ZOOLOGY AND PHYSIOLOGY.

To the President:

I have the honor to submit the following report of the Department of Zoology and Physiology for the year ending June 30, 1905.

There has been no change in the teaching force or equipment of the department during the year, and but little change in the number of classes and of laboratory sections, although the number of students handled was somewhat larger than during the preceding year. The work of the department has been seriously hampered, not only by the lack of instructors but by the lack of laboratory room and of equipment. I desire to repeat here what I have several times stated, that there has been practically no change in the facilities for teaching in this department during the past *four years*, while during the same period the number of students has more than doubled, and the number of laboratory sections has almost trebled. It is useless to pretend, under these circumstances, that the instruction given now is as good as that given five years ago; every effort has been made to keep the work up to a fair standard, but in spite of careful planning, hard work, and accumulated experience, the results show conclusively that students do not now get the thorough preparation in this department which they used to have, and which they have a right to expect.

Following is a list of the classes given during the year, with the number of exercises and hours for each student, and the names of instructors in charge. In the classes in Zoology and Geology the Agricultural and Women students have received lectures together, but the laboratory work has been in separate sections. In the classes in Anatomy separate classes have been held for the women, the 4-year freshmen and the 5-year freshmen. The Mechanical sub-freshmen were so numerous that it was necessary to divide the class in Physical Geography and put the two sections under different instructors.

CLASSES IN ZOOLOGICAL DEPARTMENT FOR THE COLLEGE YEAR, 1904-5.

Fall Term.

Zoology 3—Agr. Sen.; 3 lect. (Prof. B.), 4 hrs. lab. in 2 sect. (Prof. Barrows; Inst. Myers).

Zoology 3—Women Sen.; 3 lect. (Prof. B.), 8 hrs. lab. in 2 sect. (Prof. Barrows; Inst. Myers).

Zoology 1—Women Jun.; 3 lect. (Prof. B.), 2 hrs. lab. (Prof. B.; Inst. M.).

Zoology 1—Agr. Soph.; 3 lect. (Prof. B.), 4 hrs. lab. in 3 sect. (Prof. B.; Inst. M.).

Anatomy 1—Agr. 5-year Fresh.; 2 lect. and 1 hr. lab in 3 sect. (Inst. M.).

Winter Term.

Geology 1—Agr. Sen.; 5 lect. (Prof. B.).

Geology 1—Women Sen.; 5 lect. (Prof. Barrows).

Zoology 2—Women Jun.; 3 lect. (Prof. B.), 4 hrs. lab. in 2 sect. (Prof. B.; Inst. M.).

Zoology 2—Agr. Soph.; 3 lect. (Prof. B.), 4 hrs. lab. in 3 sect. (Prof. B.; Inst. M.).

Anatomy 2— Women Soph.; 4 lect. and 2 hrs. lab. in 3 sect. (Inst. Myers).

Anatomy 2—Agr. 4-year Fresh.; 4 lect. (Inst. Pettit), 2 hrs. lab. in 2 sect. (Inst. M. and P.).

Anatomy 2—Agr. 5-year Fresh.; 4 lect. (Inst. M.), 2 hrs. lab. in 3 sect. (Inst. M. and P.).

Phys. Geog.-Mech. Sub-Fresh.; 3 lectures (Instructor Myers).

Phys. Geog.-Mech. Sub-Fresh.; 3 lect. (Inst. Pettit).

Short Course Entomol.—5 lectures (Inst. Pettit.)

Spring Term.

Geology 2—Agr. Sen,; 5 lect. (Prof. Barrows).

Geology 2—Women Sen.; 5 lectures (Prof. Barrows).

Entomol. 1—Agr. Soph.; 3 lect. (Prof. B.), 4 hrs. lab. in 2 sect. (Prof. B.; Inst. M. and P.).

Anatomy 1—Women 5-year Fresh.; 2 lect. and 1 hr. lab. in 2 sect. (Inst. M.).

Phys. Geog.—Women 5-year Sub-Fresh.; 4 lect. (Inst. Myers).

With the large amount of class work that has fallen on the head of the department during the past year it has naturally proved impossible to make very much progress on the bird bulletin mentioned last year. A stenographer has been employed about half the time on this work, and with his help and the little time at my own disposition the large mass of notes on Michigan birds which had been collected has been systematized and arranged in card-index fashion to facilitate ready reference, and the work of preparing the final copy for the bulletin will be largely completed, it is hoped, during the summer.

I have little to add to the recommendations made last year for the improvement of the department; but I would suggest the more complete separation, in this department, of the academic work and the work of the Experiment Station, believing that the results obtained in this way will

be decidedly better for both parties. When it becomes possible, as I hope it may at once, to put the department into first-class working condition I would recommend that at least one of the new assistants be selected with a view to special work as a preparateur of specimens for the Museum and as demonstrator for the Zoological and Physiological Laboratory.

THE GENERAL MUSEUM.

The general Museum, including the insect collection, has suffered necessarily from the neglect which was unavoidable under the circumstances; but every effort has been made to protect specimens from deterioration, and from the attacks of insect pests, and we have been fairly successful, we believe, in the attempt. No special effort has been made to increase the collections, but a number of valuable accessions have been made, mainly by donation, a very few by purchase. In making additions to the collections, particularly by purchase, the principle has always been followed that the local collection, and certainly the collection of Michigan specimens, should invariably receive first consideration. We welcome donations of natural history material from any part of the world, but are especially glad to get good specimens from surrounding regions, seldom buying anything not native to the Great Lake region. We have also discouraged the collection or display of mere curios or objects of simply historical interest, lying entirely outside the pale of natural history. There are other museums in the state where such objects should find a more natural resting place and prove more useful.

Respectfully,
WALTER B. BARROWS,
Professor of Zoology and Physiology
and Curator of General Museum.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE VETERINARY DEPARTMENT.

To the President:

Dear Sir—I have nothing new to offer in making the report for the Veterinary Department for the year ending June 30, 1905. The work has been the same as in previous years. During the fall term with the seniors the anatomy of the farm animals was studied. In the forepart of the winter term twenty lectures were devoted to materia medica, considering the sources of the medicines, their physiological actions, and doses, also the conditions in which their use is indicated. The remainder of the year was spent in discussing the various diseases to which the farm animals are subject; in this discussion they are considered as to the causes, symptoms and treatment.

During the first half of the winter term the sophomores received thirty lectures treating of some of the most common diseases, emphasizing especially prevention.

The short course students received forty lectures, covering in a practical manner the common diseases, the care of animals to prevent disease, also the dressing and treating of wounds.

At the request of Prof. Shaw I gave to the regular, and also to the special students, a course of lectures upon the breeds of horses, and also took charge of the practical work in horse judging.

Respectfully submitted,
GEO. A. WATERMAN,
Professor of Veterinary Science.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE LIBRARIAN.

To the President:

Sir—I have the honor to present the following report on the library for the year ending June 30, 1905.

There have been added to the library during the year bound volumes as follows: By purchase, 342; by gift, 126; by binding, 294. We are indebted for bound volumes as follows: From

Mrs. T. C. Abbot (Abbot collection) 1.
American Hereford Cattle Breeders' Ass'n, 1.
American Short Horn Ass'n, 2.
American Aberdeen-Angus Ass'n, 1.
Bridge, J. H., 1.
Beal, Dr. W. J., 1.
Cambria Steel Co., 1.
Canada, 6.
Cranefield, F. C. (Wis. Hort. Society) 10.
Harper, Pres. W. J., 1.
Hartford Inspection Insurance Co., 1.
Holstein-Friesian Ass'n, 3.
Hampshire Down Ass'n, 1.
Iowa State Board of Agriculture, 1.
Iowa State Horticultural Society, 1.
Illinois, 1.
J. J. Case Threshing Machine Co., 1.
Kansas State Board of Agriculture, 1.
King, Prof. E. S., 1.
Maine, 2.
MacMillan Publishing Co., 1.

Michigan reports—

Board of Agriculture, 1.
Attorney General, 1.
Board of Health, 1.
Board of Corrections and Charities, 1.
Dairy and Food Commissioner, 8.
Pioneer Collections, 4.
Superintendent Institutes, 4.
Superintendent Public Instruction, 1.
Supreme Court Reports, 6.
National Conference of Corrections and Charities, 1.
Red Polled Cattle Club, 1.
Smithsonian Institution, 4.
Stubbs, W. C., 1.

United States reports—

Agricultural Department, 6.
Bureau of Education, 4.
Census Bureau, 3.
Coast and Geod. Survey, 1.
Geological Survey, 2.
Interstate Commerce Commission, 2.
Librarian of Congress, 5.
Labor Bureau, 2.
Navy Department, 1.
Treasury Department, 16.
War Department, 7.

Unbound volumes and pamphlets to the number of 477 have been received, and in all cases gifts have been acknowledged. We therefore omit individual mention.

Forty-one foreign publications and one hundred thirteen American periodicals are purchased by the college, and placed in the reading room for the use of faculty and students. In addition to these are the following

publications which are regularly received, either in exchange for our own publications, or through the courtesy of publishers.

Adrian Times,
Agricultural Advertising.
Agricultural Gazette, New South Wales.
Allegan Gazette.
American Blacksmith.
American Botanist.
American Dairymen.
American Grange Bulletin.
American Missionary.
American Society of Civil Engineers, Proceedings.
American Swineherd.
American Thresherman.
Arboriculture.
Ann Arbor Argus.
American Sugar Industry.
American Phil. Society, Phila., Proceedings.
Armada Graphic.
Battle Creek Journal.
Bay City Tribune.
Belding Banner.
Big Rapids Herald.
Boys and Girls.
Bear Lake Eagle.
Capitol City Dem.
Christian Herald.
Christian Science Journal.
Christian Science Sentinel.
Church Helper.
Congressional Record.
Chicago Daily Drovers' Journal.
Civic News.
Detroit Farm and Live Stock Journal.
Deutsch American Farmer.
Electrical Trade.
Farm and Fireside.
Farm and Home.
Farm, Field and Fireside.
Farm Home.
Farmers' Advocate.
Farmers' Guide.
Farmers' Tribune.
Farmers' Voice.
Farming World.
Farm News.
Florist's Exchange.
Fruit Growers' Journal.
Fruit Grower.
Farm and Floral World.
Gas Engine.
Gleanings in Bee Culture.
Good Health.
Grand Ledge Independent.
Gleaner.
Hillsdale Leader.
Hillsdale Standard.
Hoard's Dairyman.
Holstein Friesian World.
Home and Farm.
Homestead.
Horse Shoer's Journal.
Horse World.
Horticultural Visitor.
Improvement Era.
Indiana Farmer.
Ionia Sentinel.
Johns Hopkins University Circulars.
Journal of Agriculture, Australia.
Journal of Agriculture, Victoria.
Kalamazoo Telegraph.
Kansas Farmer.
Lansing Journal (daily).
Livestock Journal.
Michigan Mirror.
Michigan Presbyterian.
Midland Republic.
Moderator-Topics.
Mystic Worker.
Mark Lane Express.
Michigan University News Letter.
Mining Magazine.
National Farmer and Stock Grower.
New Voice.
New York Meteorology.
New York Produce Review.
New York Weekly Witness.
New Zeeland Dairyman.
Official Gazette, U. S. Patent Office.
Orange Judd Farmer.
Oregon Agriculturist.
Petoskey Independent, Democrat.
Pinckney Dispatch.
Practical Farmer.
Publicity Magazine.
Republic.
Rural Advocate.
Saginaw Evening News.
Salt Lake Herald.
State Republican (daily).
Stockbridge Brief.
Sugar Beet Culturist.
Sugar Beet.
Traverse Bay Eagle.
Wallace Farmer.
Western Swine Breeder.
Western Society of Engineers, Journal.
Williamston Enterprise.
Woman's Home Companion.
Ypsilantian.

The M. A. C. Record exchanges are placed in the reading room, and in exchange for our catalogue, the Library receives the year books, catalogues or registers from all the leading institutions of the country. We also receive the bulletins of the various state experiment stations, and of the U. S. Department of Agriculture.

During the year fines to the amount of $36.23 have been collected. The library hours remain unchanged.

To the library, of the experiment station, 87 books have been added, 10 of which were purchased, 17 were presented, and 60 from the bindery. This library now numbers 2,192 volumes. The college library contains 23,630 volumes; total in both libraries, 25,822 volumes.

The work in the library has gone on about as usual. The assistant, Miss Balbach, has been untiring in her efforts to further the interests of the library. We take pleasure in commending her, and regret that she finds it necessary to sever her connection with the college. We wish for her all possible success in whatever work she may engage.

Respectfully submitted,
LINDA E. LANDON,
Librarian.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE MILITARY DEPARTMENT.

President J. L. Snyder, Michigan Agricultural College:

Sir—I have the honor to submit the following: The oustide work in this department closed June 9th, 1905. During the Spring term the weather has been such that the work has been very much retarded.

Captain Francis E. Lacy, Jr., U. S. Army, inspected the department, May 22, 1905. These inspections are entirely too early so far as this college is concerned to make a proper showing. On this occasion the men did fairly well, much better than I expected to see when it is taken into consideration how little practice they had during the term, yet they did not come up to my ideas of what a Battalion of College Cadets should be.

I desire to call your attention to the fact that in my opinion the hour for Military instruction is too late in the day. Students who have been at their studies or in the shops all day, when they report for drill are tired and worn out, and do not feel much like drilling for an hour. Cadet Officers have informed me that they believe if the instruction was held at an earlier hour there would be much more interest taken in the drill. The present hour is especially bad in the Fall. The Companies have to enter the Armory too early on account of darkness while there is fine weather on the outside, in consequence each company has but one hour during the week for this instruction.

General Orders No. 57, dated War Department, April 7, 1905, amending G. O. No. 65, series of 1904, with reference to Colleges of this class is a change that has been much desired. As it was heretofore it was impossible to carry out the War Department orders, as it covered so much and there was not sufficient time to do it. As it is at present the orders require but three hours per week, two-thirds of which at least must be practical. This is a much better arrangement both for the Faculty and the Commandant.

The burning of Well's Hall during the past year was disastrous to the Military Department, forty-seven men lost their uniforms, and it was considered to be a hardship to require these men to purchase new uniforms

immediately, so they were transferred to the Hospital and Signal Corps temporarily. This instruction is just as important as any other. Those that return in the Fall will be required to furnish themselves with uniforms.

In the fire referred to there were two officers' swords lost, also four rifles and equipments.

During the period I purchased six officers' swords, two to replace those that were lost, and four for the company that was organized last winter. I also purchased for the Hospital Corps, five Hospital Corps Pouches, these containing everything that is necessary for "First Aid to the Injured." The War Department Instructor was very complimentary in observing the work of this Corps.

I also purchased some new instruments for the band, which leaves this organization very well equipped, but there will be other instruments that will be required in the near future.

Fifty new rifles and equipments were received from the Ord. Dept., U. S. A., during the term. They so far have not been opened, but are sealed and stored in the Armory. They may not be required in the immediate future, but it is well to have a surplus on hand, for they are liable to be required at any time. The Battalion has been fortunate in having a fine lot of young men for officers; they all have taken a great deal of interest in the work. I wish to thank them for the assistance they have given me.

Very respectfully,

W. H. KELL, Major U. S. Army,

Professor of Military Science and Tactics.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE DEPARTMENT OF ATHLETICS.

To the President:

Sir—I have the honor to present the following report of the Department of Physical Culture and Athletics for the year 1904-1905.

The general plan of the work of the department has been very similar to that outlined in my last report. The only change of note has been that the amount of indoor work was largely increased during the winter months and the interest taken in it much greater than during the previous year. Instruction was offered in Indian clubs, dumb-bells, bar-bells, free arm work, apparatus, tumbling, wrestling and the several indoor games such as hand-ball and basket ball. The work proved popular and was very largely attended although entirely optional on the part of the students. Several exhibitions were given by the young men during the winter, under the supervision of the department, all of which were successful.

The indoor work was greatly aided by the addition, at the beginning of the winter term, of considerable apparatus to the gymnasium equipment.

The usual amount of out door work was carried on during the fall and spring and the following athletic teams were regularly organized and maintained: Football, baseball, track, tennis, basket ball, relay, indoor, and tumbling. All of these were successful both in the spirit and good will shown in the work as well as in the victories won. The football team won nine out of ten games; the baseball team won twelve and lost four, the

basketball team won a majority of its games; the tumbling team won the state college championship, as did the indoor team; the track team was unusually successful, winning all of its contests, of which those especially worthy of mention were the victories from the University of Notre Dame and Armour Institute of Chicago. The track team also won the state inter-collegiate championship, scoring again, as last year, more points than the five other state colleges combined. The relay team, not only won the state inter-collegiate championship, but in the race for that honor broke the state relay record which had stood for seventeen years.

The athletic field has been materially improved during the year. The entire field has been tile drained, the track resurfaced and a cement and sand stone curb added, while the seating capacity of the field has been largely increased by the addition of a new block of bleacher seats. The most important work done, however, in connection with the field has been the making of a survey and plat so that all improvements made during the year and outlined for the future will be permanent.

On June 3d and 4th the Michigan State Inter-collegiate Field Meet was held on the field, under the management of the department. It was unusually successful and proved an excellent thing for the college as it attracted some three or four thousand visitors to the college grounds during the two days.

Respectfully submitted,
C. L. BREWER,
Director of Athletics.

Agricultural College, Mich., June 30, 1095.

REPORT OF THE DEAN OF SPECIAL COURSES.

To the President:

The numbers in attendance at the special courses given in the winter of 1904-5 were as follows:

Creamery	49
Live stock	80
Cheese	26
Fruit	7
Total	162

The courses are all eight weeks long except the cheese course, which followed the others and was but four weeks long.

The work in the creamery course did not differ from that of the previous year except that the attendance was restricted to men who had had a year's experience in a creamery and, as a consequence, less emphasis was placed upon the work in the practical butter room and more upon bacteriology and kindred studies which supplemented or explained the methods used in the butter room. The intelligence of the class was of a high order and their energy and hunger for knowledge, exceedingly satisfactory. The college has certainly done a great deal of good to the dairy interests of the state by thus training a lot of intelligent and energetic men to manage her factories.

At the completion of the special course in live stock husbandry a majority of the students expressed a desire to continue their connection with the college by taking an advanced course next winter in which certain new features, including farm mechanics, work at the forge, and at the bench, and more extended dairy work, should be prominent, but in which stock judging should still form an essential part. Such an advanced course should certainly be given to satisfy a demand of which this is but one expression. In the course as given there is little opportunity to bring any one subject to a definite conclusion. The time given to stock judging is as great as the demands of other studies could possibly allow. It could not be carried far enough to make experts of the students although it gave them a sufficient insight to make them hungry to carry the work farther. In stock feeding time allowed but for an elementary consideration of nutrients, a brief review of the theories of nutrition and the merest statement of the composition and values of certain food products. The students were prepared to make practical application of what they did learn but there was left much of the essentials for a supplementary course.

Viewing the live stock course as a whole, it cannot fail to appear as one of the most promising avenues through which the usefulness of the college is to be extended to the state at large. It is my desire, therefore, to put forth every effort for the development of this course which is less technical than the others and wider in its promise and scope. We should have an attendance of several hundred to this course alone, but here the limitations of the equipment are felt. Several distinguished men visited the college to address our classes but there was no room large enough to hold all of the students in the special courses, save the chapel, and that was not adapted to the purposes of the lecturer. At the regular classes some of the students had to be perched upon stools and most of them were seated upon benches without arm rests or places for note books. Until larger class rooms and more of them are provided it seems an injustice to the public to widely advertise the course.

The fruit course had an attendance of seven. These young men were thoroughly interested and enthusiastic but had the energy and money used in advertising this course been devoted to advertising the live stock course, it would have attracted many more students to the college.

Hereafter the number of students allowed in the cheese course should be limited to twenty, since the cheese room cannot accommodate more than that number without great inconvenience.

The college is to be congratulated upon both the numbers of students in attendance at the four special courses and upon the interest and enthusiasm displayed.

Respectfully submitted,
C. D. SMITH,
Dean of Special Courses.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE SECRETARY OF THE FARM HOME READING CIRCLE.

To the President:

During the past year the college has exercised about the same influence over the farming methods of the state as in years gone by as far as this branch of the service is concerned. The work has not been at all satisfactory as there is entirely wanting a personal influence.

For this reason I offer the following somewhat radical suggestion based upon the personal experience of the Secretary of the Circle: I recommend that an appropriation not to exceed $200.00 be made to the Secretary of the Farm Home Reading Circle to pay for postage, paper and mimeographing.

I recommend farther that the Secretary be authorized to edit a systematic series of articles on soils, plant life, farm crops, and feeding domestic animals.

I recommend farther that these articles be sent to one paper in each county for publication.

I base these recommendations on the results of an experience during the past winter. I solicited the cooperation of certain county papers in an investigation of the value of local papers as channels through which information could be furnished farmers and their families. I paid the postage and all expenses as well. A series of articles was furnished. The subject chosen was one supposed to be the driest and most difficult of successful handling. Forty-five papers published the series. Reports coming to me indicate that as a result of the work, many thousand readers gained a much clearer knowledge of the soil than they had had or than they had other opportunity to secure. Unfortunately, comparatively few young people answered the questions sent out, and I have no means of knowing how exact the knowledge derived from reading the articles really was. In view of the success of this preliminary test, I recommend that the matter be tried in the Farm Home Reading Circle, in cooperation with selected newspapers in each county in the state.

Respectfully submitted,

C. D. SMITH,

Secretary of Farm Home Reading Circle.

Agricultural College, Mich., June 30, 1905.

REPORT OF STATE INSPECTOR OF NURSERIES AND ORCHARDS.

Hon. C. J. Monroe, President State Board of Agriculture:

Sir—The work performed by the state inspector and his deputies has been upon a larger scale than in other seasons especially so far as the orchard inspection is concerned. Most of the work of inspecting nurseries was, as in previous years, done during the months of August, September and October. A comparatively small amount of nursery stock, however, was

examined in November and April in nurseries that made no fall deliveries.

The nursery stock examined during the year compared well with that inspected in other years and as the season was favorable for its growth, it was very free from the attack of plant lice and similar insects. The San Jose scale was again found on a few trees in the nurseries reported last year and the usual steps were taken in the way of destroying the infested trees and fumigating all others before certificates were granted. It was also found in two other nurseries but in both cases the infested trees were in small detached blocks away from most of the stock and comparatively few trees were involved. In both of these cases as well as in all other in which nursery stock has been found to be infested with the San Jose scale, the insects had spread to the nursery stock from neighboring orchards. This emphasizes the importance of separating nursery business and fruit growing as far as possible and of not planting blocks of trees in close proximity to orchards.

I am glad to report that in all cases the nurseries have cheerfully carried out the instructions in the way of destroying infested trees and in the fumigation of the stock.

For the most part, the proprietors of nurseries in the state were quite prompt in taking out their licenses but the dealers were in some instances rather slow in giving the matter attention. About the usual number of foreign nurseries took out licenses to cover business done in the state by their agents.

During the year visits have been made to all of the counties in which the scale has been reported. New areas infested with the scale have been found in Kent county, in Van Buren, Berrien, Oakland and Ionia. In other counties where infested orchards have been found in previous years, the areas have broadened in most cases. The owners of infested orchards are becoming impressed with the injury that may be caused by this insect and in a great majority of cases have taken measures to control it. Although every effort has been made through bulletins, letters and horticultural gatherings and farmers' institutes to show the necessity for thorough treatment, comparatively few have given the orchards the attention they should have received. In some cases the trees should have been carefully pruned before the spraying was done and in others examination of the trees showed that considerable areas upon the branches had not been touched. The imperfect spraying was due to the fact that the wind made it a difficult task, while in others the spraying outfits were not adapted to the purpose.

The remedy that has been relied upon in most cases has been 15 pounds of sulphur, 25 pounds of lime and 8 pounds of salt in 50 gallons of water, boiled for at least one hour. This has been very effectual, especially upon young trees and others with a smooth bark that are not so large but what they could be thoroughly sprayed. The results upon large apple trees have been less satisfactory as the rough bark makes it difficult to reach all of the scale and as hand pumps are used in most outfits comparatively few of the trees have been thoroughly sprayed. The fuzzy growth upon the young twigs of many varieties also serves to protect the scale. It can be said, however, that the remedy has been very reliable whenever the applications have been thoroughly made and the results have been especially good when the applications have been made during the early part of April.

In some cases other remedies have been used. Caustic soda when applied

at the rate of from 5 to 8 pounds in 50 gallons of water has shown very little effect, but when from 15 to 25 pounds have been used in 50 gallons of water, the scales have been very thoroughly eradicated and the beneficial results upon the trees have been very noticeable, the rough bark falling off and the surface taking on a yellowish-green, glossy appearance. A patent preparation known as "Con-sol" was also tried in some orchards. The results in 1904 were not satisfactory but the manufacturers claim that the mixture has been strengthened and that it will now give good results. It is now too early to speak definitely regarding it. In a few places kerosene, either in the form of a soap emulsion, or the K-L (Kerosene-Lime) mixture has been tested. While less desirable than the sulphur and lime mixture for most purposes, a spray prepared of the kerosene makes it desirable for use upon apple trees both young and old.

While winter and early spring applications should be relied upon for the control of this insect, it often happens that its presence was not noted in time, or perhaps owing to a lack of thoroughness or other causes, the results were not effectual. Under these conditions it becomes desirable to spray the trees during the summer months in order to prevent serious injury to the trees and perhaps the loss of the fruit crop. Although it is difficult to reach the insects as readily at this time as during the dormant period, much good can be done if the treatment can be given soon after the broods appear. At this time the use of kerosene emulsion, K-L, or other applications that will be effectual against the young scales without injuring the trees may be made to advantage.

The work that was referred to in the report of last year relating to the control of the disease known as "little peach" which has prevailed for a number of years in the orchards of western Allegan county and in other sections along the Lake shore has been continued in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture. The work was in charge of deputy Horace G. Welch. Although representatives of the Department of Agriculture have again spent several weeks studying the disease in the field and laboratory, they have no additional light regarding the nature of the disease. The orchards in the section where the work has been done were examined three times during the season and all infested trees removed. As compared with last year, the results have been very satisfactory, as the number of trees showing symptoms of the disease was only one-fourth that found in 1903. This indicates that there is a prospect that the disease can be controlled by the prompt removal of infested trees.

DEPUTIES.

The deputies reported as in service one year ago still remain on the list subject to call except Mr. J. M. Rankin, who resigned August 1st to accept an appointment with the U. S. Department of Agriculture, Washington. The greater part of the work of inspecting nurseries was performed by the remaining deputies, T. A. Farrand, South Haven; H. G. Welch, Douglas; E. W. Allis, Adrian; and R. G. Stahelin, Bridgman. Mr. Farrand and Mr. Welch also devoted considerable time to the inspection of orchards but the work along this line performed by Messrs. Stahelin and Allis was for the most part in their own counties.

LEGISLATION.

In previous reports mention has been made of defects in the state law relating to the inspection of orchards and nurseries and at the suggestion of the State Horticultural Society and many nurserymen and fruit growers of the state, a bill was prepared by myself, and introduced by Senator Cropsey of Kalamazoo County, to correct the imperfections. For the most part it merely combined the three laws previously upon the statute books and unified the requirements. The principal changes were to make the spraying and yellows laws applicable to cities and villages as well as townships, and to give the state inspector of nurseries and orchards authority to enforce the law so far as orchards are concerned.

I append a list of the firms licensed to sell nursery stock in Michigan. Those first named include such as are engaged in the propagation of trees and plants for sale, to which is added the list of dealers in nursery stock, and the foreign nurseries that have agents selling stock within the state:

MICHIGAN NURSERIES LICENSED IN 1904-05.

Allen, R. E	Glendale, No. 1
American Nursery Co	Kalamazoo
Babcock & Nash	Bridgman
Baldwin, O. A. E	Bridgman
Baker, Chas. H	Plainwell
Bigelow, J. N	Bangor
Bragg, L. G. & Co	Kalamazoo
Briscoe, Joseph A	Highland Park
Brooke, F. W	Ithaca
Biehler, E. J	Stevensville
Central Michigan Nursery Co	Kalamazoo
Cross, Jas. A	Spring Lake
Culver, O. B	Colon
Curtis, L. T	Flint
Cutler & Hamilton	Benton Harbor
Davis, G. B	South Haven
Dean, Geo. N	Shelbyville
Dow, H. C	Spring Grove
Dressel, G. L	Frankfort
Dunham, E. W	Stevensville
Emmanuel Missionery College	Berrien Springs
Essig, W. W. & Co	10 Cleland Bldg., Detroit
Ferrand, E. & Son	Vinewood Ave., Detroit
Flansburgh & Peirson	Leslie
Goodell, E. W	Mayville
Green, A. W. & Son	Grass Lake
Greening Brothers	Monroe
Gustin, C. F	Adrian
Hamilton, A. & Son	Bangor
Havekost, G. H	Monroe
Hodges & Son	Mayville
Hawley, E. & Sons	Hart
Herbst, Wm. G	Maybee
Hetler, J. M	St. Joseph
Husted, N. P	Lowell
Ilgenfritz, I. E. Sons' Co	Monroe

Jaquay, Irving Co	Benton Harbor
Jeffrey, James, Jr	Bronson
Jeffrey, James, Sr	Kalamazoo
Kalamazoo Nurseries	Kalamazoo
Kellogg, R. M. Co	Three Rivers
Knight, David	Sawyer
Lake Shore Nursery Co	St. Joseph
Lamson & Rood	Covert
Leathers, William J. & Co	Breedsville
Lewis, A. E. & Sons	Lowell, R. D.
Muchmore, Wm. O	Augusta
Maudlin, E	Bridgman
McKee, H. R	Coloma
Michigan Nursery Co	Monroe
Morley & Dyer	Benton Harbor
Morrill, R	Benton Harbor
Munson, W. K. & Son	Grand Rapids
McNeil, R H	Bridgman
Michigan Nursery and Orchard Co	Kalamazoo
Muskegon Nursery and Fruit Growing Co	Muskegon
Negaunee Nurseries and Greenhouses	Negaunee
Nelson, J. A. & Son	Paw Paw
Newaygo County Nursery Co	Fremont
Northwestern Nursery Co	Muskegon
Oregon Nursery Co	Detroit
Paw Paw Valley Nursery Co	Coloma
Pearce, P. D.,	48 Livingston St., Grand Rapids
Pomona Nurseries	Ada
Prater, G. E., Jr	Paw Paw
Proctor, J. R	Caledonia
Sheldon, P. B. & Son	Litchfield
Singer, W. H	Lapeer
Speyers, Chas. M	Willis
Spielman Bros	Adrian
Stone, John & Son	Hillsdale
Watterson, W. J. & Son	Ada
Webb, D. S. & Co	St. Joseph
West Michigan Nurseries	Benton Harbor
Weston, A. R. & Co	Bridgman
Whitten, C. E	Bridgman
Wilber, M. B. & Son	Mecosta
Wise, Ralph, R. D. No. 1	Plainwell
Wooll & Tillotson	Elsie

MICHIGAN DEALERS IN NURSERY STOCK.

Alferink, Alfred, R. D. No. 8	Holland
Augustine, L. D	Watervliet
Bagley, W. D	Old Mission
Booske, Adolph	Marine City
Braman, O. W., R. D. No. 4	Grand Rapids
Carmon, Myron	Dowagiac
Campbell, A. H	Mattawan
Cole, Levant	Battle Creek

Davis, S. B. Jackson
Dodge, Thos. T. Lawton
Davison Nursery Co. Davison
Dumphry, W. C., Sr. Battle Creek

Healy, William. Bloomingdale

James, Arthur M. Midland

Kimball, D. S. 47 Aurelia St., Detroit
Knapp, Chas. E. Lawton
Knapp, W. F. Monroe

Mosier, C. H. Paw Paw

Pearson, D. S. 173 Hastings, St., Grand Rapids

Sessions, C. E. Ionia
Shepard, Andrew G. Paw Paw
Souter, Geo H. Holland
Strittmatter, Adolph. 488 Chene St., Detroit
Sweet, L. H. Carsonville

Taplin, Stephen. West Fort St., Detroit
Taylor, Frank J. Hartford
Thrasher, C. D. Hamburg

Washington Nursery Co. Detroit

FOREIGN NURSERIES.

Albaugh Nursery Co. Phoneton, Ohio
Allen Nursery Co. Rochester, N. Y.

Bogue, Nelson. Batavia, N. Y.
Brown Brothers Co. Rochester, N. Y.
Bowman, Thos. W. Rochester, N. Y.
Bryant Brothers. Dansville, N. Y.

Charlton Nursery Co. Rochester, N. Y.
Chase Brothers Co. Rochester, N. Y.
Chase, R. G. Co. Geneva, N. Y.
Cole, W. B. Painesville, Ohio
Costich, G. A. Co. Rochester, N. Y.

First National Nurseries. Rochester, N. Y.
Franklin Davis Nursery Co. Baltimore and Paca Sts., Baltimore, Md.

Harmon, M. H. Co. Geneva, N. Y.
Hawks Nursery Co. Rochester, N Y.
Hooker, Wyman & Co. Rochester, N. Y.
Herrick Seed Co. Rochester, N. Y.

Jewell Nursery Co. Lake City, Minn.

Knight & Bostwick. Newark, N. Y.

McKay Brothers. Pardeeville, Wis.
Mayfield Nursery Co. St. Paul, Minn.

North Jersey Nurseries. Springfield, N. J.

Olver Brothers. Rochester, N. Y.

Peirson Brothers. Waterloo, N. Y.
Perry Nursery Co. Rochester, N. Y

Spaulding Nursery and Orchard Co	Spaulding, Ill.
Stark Brothers Nursery Co	Louisiana, Missouri
Stuart, C. W. & Co	Newark, N. Y.
The Van Dusen Nurseries	Geneva, N. Y.
Western New York Nursery Co	Rochester, N. Y.
Whitney, G. W. & Co	Dansville, N. Y.
Willett, Eugene	North Collins, N. Y.

Respectfully submitted,
L. R. TAFT,
State Inspector of Nurseries and Orchards.

Agricultural College, Mich., June 30, 1905.

REPORT OF SUPERINTENDENT OF FARMERS' INSTITUTES.

President J. L. Snyder:

Sir—I submit herewith the report of the Farmers' Institutes held in the State during the year ending June 30, 1905.

The series of institutes held during the past year have, for the most part, been even more successful than in previous years despite the fact that severe snow storms seriously interfered with the attendance in a large number of counties. It so happened that at the time the weather was most severe a considerable portion of the institutes were being held and they were located in counties where the attendance has been very large under favorable conditions. Judging from the attendance in other counties, it is probable that the number of persons in attendance at each of the institutes held during the stormy period was from 500 to 1,200 less than would have been recorded as present had the weather been reasonably pleasant.

The institutes in nearly all of the counties have been unusually good. In a few cases sufficient care was not given to the selection of a secretary and other officers and it was difficult to perfect the arrangements for the meetings. Last year institutes were held in seventy-three counties and in 1904-05 the number of counties in which one or more institutes were held was the same. For various reasons no institutes were held in Bay, Houghton, Montmorency and Oscoda counties but the organizations have been kept up and meetings will probably be arranged for the coming year. The following counties organized institute societies and held one or more institutes during the season: Dickinson, Delta, Luce and Missaukee.

The county institute societies have been maintained and have proved of great service in arranging and conducting the institutes. All of the local arrangements have been cared for by the executive officers. At the present time there are county organizations in all of the counties in the Lower Peninsula except Roscommon, and there are county societies in nine counties of the Upper Peninsula, in eight of which institutes were held during the last year.

Within the year 200 one-day institutes were held. A large number of the counties asked for a considerable increase in the number of these meetings, but in order to bring the expenses within the appropriation, it was necessary to reduce the number even below that granted in 1903-04. The

attendance at the one-day institutes was relatively larger than last year and even with the smaller number of meetings, the total number in attendance would have been greater had it not been kept down by severe storms which made it impossible for the people from a distance to reach the halls where the meetings were held.

Owing to the fact that the time of the members of the faculty of the Agricultural College and the staff of the Experiment Station is very fully occupied and that they are only able to devote at most, one or two weeks to attendance upon farmers' institutes, it has, as in previous years, been found necessary to secure a large number of outside speakers. Of these a very large proportion had been upon the force of institute workers for several years. Two speakers were secured from other states, namely, W. W. Farnsworth, of Waterville, Ohio, President of the Ohio State Horticultural Society, and D. Ward King, Maitland, Missouri, the Good Roads expert of the Missouri State Board of Agriculture and well-known as the inventor and advocate of the King road drag. As a partial recompense for the time devoted to the making of arrangements for the county institutes, quite a number of the secretaries of county institute societies were utilized as speakers at the meetings in other counties.

The appropriation for the holding of farmers' institutes would have been far from sufficient to defray the expense had it not been for the active and efficient cooperation of a large number of persons who in several cases devoted three or four weeks of their time without pay to attending the meetings. Especial credit is due as follows: From the Department of Public Instruction, Hon. P. H. Kelley, Superintendent, Professor W. H. French, Deputy Superintendent and Professor A. Hamlin Smith, Chief Clerk; from the Central Normal School, Principal C. T. Grawn, Professors F. L. Keeler and Larzelere; from the Western Normal School, Principal D. B. Waldo and Professor Ernest Burnham; from the State Forestry Commission, President Chas. W. Garfield and Professor Filibert Roth, State Forester; from the State Highway Commission, Hon. H. S. Earle, State Highway Commissioner and Frank F. Rogers, Deputy Commissioner; from the State Dairy and Food Commission, Colon C. Lillie, Deputy Commissioner; Professor R. D. Bailey of Gaylord; Professor H. C. Lott, of Elk Rapids; Professor Clarence E. Holmes, of the State School for the Blind; Hon. D. E. McClure, Lansing; and Professor Delos Fall, of Albion College.

Much of the interest and value of the two-day institutes and to some extent of the one-day was due to the many valuable papers presented by local speakers and to the discussions that followed.

THE ROUND-UP INSTITUTE.

The Annual Round-up Institute was held at Battle Creek upon the invitation of the Calhoun County Farmers' Institute Society and the Battle Creek Business Men's Association. The attendance was good from all parts of the state and especially from the neighboring counties, while the local attendance was the largest for some years. A conference of the institute lecturers and county secretaries was held on Monday evening, February 27 and on Tuesday morning and afternoon. Reports were received from the work of the past year and plans for the future were discussed. Several of the lecturers and secretaries who have had a number of years' experience in institute work, gave short talk upon such topics as adver-

tising the institutes, securing members, getting up the program, the women's section, interesting the young people, the ideal institute lecturer, etc.

Among the topics discussed at the institute proper were, Poultry, Farm Crops, Potato Culture, Beans, Corn and Its Improvement, Alfalfa, Legumes and Soil Inoculation, Good Roads, Forestry, Insects and Diseases Injurious to Plants, the Selection and Feeding of Steers, Sheep and Hog Raising, Dairying, the Silo, Fruit Growing, Agriculture in the Public Schools, Rural Schools and Their Improvement.

The faculty of the Agricultural College took a prominent part in the program and the assistance rendered by the Department of Public Instruction, Western Normal School, Forestry Commission and the Good Roads Commission aided materially in the success of the meeting. Quite a number of the regular institute lecturers filled prominent places upon the program in an acceptable manner. Several speakers from other states were also secured. Among them were Prof. Herbert W. Mumford, of the University of Illinois, Prof. A. G. McCall, Ohio State University, Prof. S. H. Fulton, of the U. S. Department of Agriculture, Prof. O. J. Kern, County Superintendent of Schools, Rockford, Illinois, and D. Ward King, the Highway Expert of Missouri State Board of Agriculture. The addresses of all of these gentlemen were well received and brought out warm discussions.

On Thursday evening the speakers, delegates and visitors were the guests of the Battle Creek Sanitarium at a banquet and the evening program was given in the large gymnasium at the Sanitarium. This was the largest session held, fully one thousand being present.

Much of the success of the Institute was due to the work of the officers of the Calhoun County Farmers' Institute Society and of the Battle Creek Business Men's Association in arranging for and thoroughly advertising the meeting. Especial praise should be given to the officers of these associations and the chairman of the various committees having the arrangements in charge. Miss Clara E. McDermid acted as chairman of the Women's Congress which met in the Baptist Church on Wednesday and Thursday afternoons. The attendance and interest was good upon both occasions.

The committee on resolutions, in addition to the usual thanks to all concerned in promoting the success of the institute, made several recommendations, all of which were unanimously adopted; among them were the following:

The holding of the Round-up Institute at the Agricultural College at least each alternate year; the extension of all lines of agricultural instruction such as farmers' institutes, correspondence courses, reading circles, and study clubs, or other methods for rural improvement, and recommend that all such college extension work be organized under one management; commending Governor Warner's efforts in fostering the dairy interests of the state; favoring National, State and local cooperation in public wagon road building and improvement; urging the establishment by the National Government of a parcel post system and the further extension of the rural mail delivery service; favoring an appropriation for the erection on the Agricultural College grounds of an auditorium sufficiently large and complete to serve for college commencement and other public meetings.

PROSPECTS FOR THE COMING YEAR.

Plans are already under way for the institutes to be held in 1905-06 and, from the correspondence with the officers of the local societies, it is evident that the interest in farmers' institutes is on the increase. This is shown particularly in the calls for one-day institutes. The appropriation last year, $7,500.00, made it impossible even then to hold all of the institutes that were asked for. At the present time, requests have been received for at least fifty per cent more meetings than were held in 1904-05, and many counties would have asked for a larger number had they not already reached the limit set in previous years. The increase in the number of requests comes not only from the counties that have held one-day institutes in previous years but a dozen or more counties that have never held one-day institutes are asking for from two to six each. As the holding of an increased number of institutes in each of the counties will merely add to the cost for the per diem of the speakers with little or no increase for traveling or board bills, it being the rule that the speakers at one-day institutes shall be entertained while within the county, it will be possible to hold fifty per cent more one-day institutes than last year without adding more than twenty-five per cent to the expense. In view of the increased interest and calls for one-day institutes, I would suggest that provision should be made to hold not less than three hundred such meetings during the coming year.

L. R. TAFT,
Superintendent of Farmers' Institutes.

Agricultural College, Michigan, June 30, 1905.

REPORT OF MICHIGAN WEATHER SERVICE FOR THE YEAR ENDING JUNE 30, 1905.

The work of the Michigan Weather Service during the past fiscal year has been carried forward on lines similar to those of preceding years.

Mr. C. F. Schneider, Section Director, U. S. Weather Bureau, has continued in charge and the location of the headquarters of the Service has remained at Grand Rapids.

The Service has in operation a total number of 121 voluntary observers' stations. In addition there are eight regular Weather Bureau Stations in the state, which makes a total of 129 places at which meteorological records are made. As a whole, the reports of the voluntary observers have been very satisfactory, but in spite of our utmost efforts the personnel is constantly changing. It should be remembered that the observations are taken entirely without remuneration. During the past year great efforts have been made to overcome this defect by enlisting the cooperation of the municipal authorities and having them in turn make it a part of the duties of some municipal employee to take the necessary daily observations, which requires not more than ten minutes at the most to make and record. Our policy has been not to disturb any voluntary observer who is doing good work. A large number of stations in the southern part of the state have been re-established during the past year at Water Works Pumping Plants through the cooperation of the municipal authorities. We find this an

admirable scheme for many reasons, principally because the location of a City Water Works Pumping Plant usually affords an ideal location for the exposure of the thermometers and rain gauge and secondly, because there is always someone on duty at such a station day and night throughout the year whose time will permit of a short diversion lengthy enough to make an observation carefully and promptly. Finally, by making a business arrangement with the municipal authorities my office is reasonably assured that the work will be carried forward properly and, additionally, the services of the men thus secured are always intelligent. From the standpoint of the municipal authorities the arrangement has its advantages, because it secures for their city a meteorological record from reliable and accurate instruments and the work is carried on under the competent supervision of the U. S. Weather Bureau, making it comparable and homogeneous with all other work of this kind in the U. S. The record to the municipality is very valuable in many ways and supplies information for current and reference use that is coming into demand more and more every day. In fact, the meteorological records now being accumulated are being used in so many ways that there is hardly any branch of modern business that does not consult them at one time or another.

Recently the U. S. Weather Bureau officially changed the designation of these stations from "Voluntary Observers Stations" to "Cooperative Observers Stations," thinking that the term was more comprehensive.

In the distribution of forecasts and special warnings we have made a decided advance, owing to the wide and general increase of farmers' telephones. We now have an arrangement with the principal Telephone Companies of the state whereby our forecasts are distributed, without cost, to nearly all of their various exchanges before 11:00 a. m., each morning. By advertisement in their directories and otherwise their telephone subscribers are advised that by calling up "Central" any time after 11:00 a. m. they can secure the weather forecasts for "tonight and tomorrow." At present over 43,000 telephone patrons are thus supplied with forecasts and I hope to be able to perfect arrangements during the coming year whereby every farmer who has a telephone will be able to secure the weather forecasts by simply calling up his "Central."

The Weekly Climate and Crop Bulletin has been published during the planting, growing and harvesting seasons as in the past and continues to meet with the favor of the public generally. We have a weekly mailing list of about 1,300 of these bulletins, which is greatly extended and amplified by the metropolitan newspapers and a large number of the smaller weekly and semi-weekly newspapers. We consider the information very reliable. It is obtained from a corps of about seven hundred correspondents who report weekly to this office. Their reports are mailed so as to reach the Grand Rapids office by Monday noon and the Bulletin is issued to the public Tuesday noon.

The monthly and annual publications contain statistical meteorological data, reported by voluntary observers and regular Weather Bureau Stations and have been published in the same style and form as in previous years. The data is all displayed in detail and tabulated homogeneously with reports published in the other states in the Union, so that it can be readily compared with any other report issued in any other state. These monthly and annual reports are very widely sought for.

C. F. SCHNEIDER,
Director.

EIGHTEENTH ANNUAL REPORT

OF THE

EXPERIMENT STATION

OF THE

STATE AGRICULTURAL COLLEGE OF MICHIGAN

UNDER THE HATCH ACT

FOR THE

YEAR ENDING JUNE 30, 1905.

For members and organization of the State Board of Agriculture in charge of the Station, and list of officers, see page nine of this volume.

EXPERIMENT STATION.

REPORT OF SECRETARY AND TREASURER.

The following account shows the receipts and expenditures of the Experiment Station for the year ending June 30, 1905.

		Dr.	Cr.
July 1, 1904	—To balance on hand	$3,881 87	
July 9, 1904	received from U. S. Treasury	3,750 00	
Oct. 6, 1904	received from U. S. Treasury	3,750 00	
Jan. 4, 1905	received from U. S. Treasury	3,750 00	
April 10, 1905	received from U. S. Treasury	3,750 00	
June 30, 1905	license fees on 124 brands commercial fertilizers	2,480 00	
	miscellaneous receipts	298 80	
	farm receipts	1,718 51	
	from State appropriation, So. Haven	1,000 00	
	from State appropriation for U. P. Experiment Station	2,500 00	
	U. P. Experiment Station, receipts	216 40	
	South Haven Experiment Station receipts	624 91	
June 30, 1905	—By disbursements as per vouchers filed in the office of the State Auditor General	....	$26,461 22
June 30, 1905	balance on hand	....	1,259 27
		$27,720 49	$27,720 49

Forty-two thousand copies of each regular station bulletin are now issued, and the demand is increasing as farmers learn of their value. Several press bulletins have been issued and special information in bulletin form has been sent out by the station.

DISBURSEMENTS ON ACCOUNT OF U. S. APPROPRIATION.

Salaries:		
Director and administrative officers, No. employed 7	$2,262 95	
Scientific staff, No. employed 7	2,999 80	
Assistants to scientific staff, No. employed 5	1,021 03	
		$6,283 78
Labor:		
Monthly employes, 2; average rate, $45.00	$1,080 00	
Monthly, weekly, daily and hourly employes	2,349 77	
		3,429 77
Publications:		
Half tones, mailing list, etc	$191 50	
		191 50
Carried forward		$9,905 05

Brought forward		$9,905 05
Chemicals:		
Chemical supplies		190 90
Seeds, plants and sundry supplies:		
Agricultural	$146 53	
Entomological	56 35	
Botanical	16 25	
Miscellaneous	364 96	
		584 09
Tools, implements and machinery:		
Repairs	$93 51	
New purchases	107 60	
		201 11
Furniture and fixtures:		
One case	$30 68	
One case	63 80	
One typewriter	90 00	
Sundry fixtures	25 41	
		209 89
Scientific apparatus:		
One Zeiss microscope	$368 98	
Sundry items	589 81	
		958 79
Live stock:		
Cattle	$961 75	
Swine	221 39	
Sundries	15 70	
		1,198 84
Traveling expenses:		
In supervision of station work	$99 84	
For other purposes connected with station work	111 98	
		211 82
Building and repairs		22 75
Postage and stationery		583 38
Freight and express		201 44
Feeding stuffs		332 22
Library		303 48
Heat, light and water		96 24
Total		$15,000 00

DISBURSEMENTS OF EXPERIMENT STATION—MONEYS OTHER THAN RECEIVED FROM UNITED STATES TREASURER.

Salaries	$3,176 21	
Labor	5,339 73	
Postage and stationery	113 05	
Freight and express	163 33	
Heat, light and water	93 97	
Chemical supplies	48 30	
Seeds, plants and sundry supplies	1,219 35	
Fertilizer	98 20	
Library	52 05	
Tools, implements and machinery	163 31	
Scientific apparatus	101 49	
Building and repairs	111 14	
Traveling expenses	300 45	
Feeding stuffs	480 64	
		$11,461 22
Balance on hand		1,259 27
Total		$12,720 49

REPORT OF THE DIRECTOR AND AGRICULTURIST.

To the President:

There have been issued during the year ending June 30, 1905, the following bulletins:

No.	Title.	Author.	Department.	Pages.
217	Fertilizer Bulletin	F. W. Robison	Chemical	23
218	Some Essential Changes Brought About in the Soil by Micro-organisms	S. F. Edwards	Bacteriological	7
219	Soil Moisture, its Importance and Management	J. A. Jeffery	Farm	10
220	Dried Beet Pulp and Dried Molasses Beet Pulp for Fattening Sheep	R. S. Shaw	Farm	10
221	Care and Handling of Milk	C. E. Marshall, W. R. Wright, John Michels	Bacteriological	
222	The Codling Moth, in Michigan	R. H Pettit	Entomological	
223	Swine Equipment and Feeding	R. S. Shaw	Live Stock	
224	Influence of Nodules on the Roots upon the Composition of Soy Beans and Cowpeas	C. D. Smith and F. W. Robison	Farm	
225	Alfalfa in Michigan	C. D. Smith	Farm	
226	Review of Special Bulletins	C. D. Smith, L. R. Taft	Farm	
227	Legumes Other than Alfalfa	C. D. Smith	Farm	
	Special Bulletins:			
30	Report of the South Haven Sub-station	T. A. Farrand		
31	Report of the Upper Peninsula Sub-station	L. M. Geismar		
32	Investigations in Animal Nutrition	F. W. Robison	Chemical	

It is pleasant to report that there have been few changes in the station staff during the year. Prof. B. O. Longyear resigned as botanist of the station in midsummer 1904, to undertake similar work in Colorado. Mr. Longyear brought to the work of the station a mind well equipped with a knowledge of systematic botany and histology and a thorough training in station methods. He had the investigation well in hand when he was called to a better position in Colorado. Mr. Longyear was associated with this college and station for a great many years. He has performed the work which fell to his department with precision, accuracy and enthusiasm. His study of edible fungi was especially conspicuous not alone for its immediate practical value but for the addition it has given to our knowledge of this interesting class of plants.

Prof. Floyd W. Robison resigned as chemist of the station in April, 1905, to become state analyst and chemist of the State Dairy and Food Commission. I wish to record here our appreciation of the ability and enthusiasm of Professor Robison. He came to us from the noted Columbus Laboratory of Chicago in which he had done most excellent service for several years since his graduation. His work at this station was characterized by originality and initiative as well as by accuracy and faithfulness in execution. While his connection with the Dairy and Food Commission will assure the state that it is not to lose his services, his departure from the college will be a distinct loss to this institution.

As his successor, Andrew J. Patten of the Geneva, N. Y. Station has been selected.

The report of the Superintendent of the Upper Peninsula Experiment Station shows that while good work has been done in demonstrating the adaptability of certain cereals to Upper Peninsula conditions, still the small area of cleared land limits not only the number of experiments which can be undertaken but their efficiency as well. It is demonstrated annually that until the cleared area shall be increased to at least 60 acres no definite experiments of permanent value on cultural methods can be undertaken. I am glad to report that at the close of the year the state legislature has appropriated the sum of $9,000 to add to the equipment of the station and to clear and drain more land. The present plans include the proposition to cut off the timber from the next forty west of the present cleared area and to put in necessary drains, to add live stock and live stock experiments to the present equipment and to enlarge the present barn and house room. No conspicuous results are to be recorded for the work of last season. The practice of planting potatoes in the fall still continues with unvarying good success. All root crops do well in the central section of the Upper Peninsula and fall wheat is to be recommended in every respect save that the harvests come at a season of the year when wet weather is certain. Oats succeed most admirably giving a good yield of grain with stiff straw. The early varieties only are to be recommended since rust is always present. As a grain crop for feeding swine or even for horse feeding, barley is used wherever corn finds a place in the ration of the live stock of the farmer of southern Michigan.

As to the garden vegetables the broad statement may be truthfully made that all of them that are successfully grown in the central part of the southern peninsula succeed at Chatham with the exception of sweet corn and tomatoes, which do not mature in this latitude, far enough to warrant attempts at their growth. The orchards, although growing thriftily, are threatened by the annual excessive snowfall which, on the level, amounts to at least four feet at some season of the winter. This snow drifts in the orchards breaking down the limbs from the trees which must be headed low to prevent injury to the south side of the trunks by the bright sunshine on the crust of the midwinter snow. Of the apple trees seven varieties have borne fruit the past year, all Russians. There is a good promise of successful apple culture in central northern Michigan to supply the immediate needs of the markets during the fall. The winter sorts will necessarily be imported from some more favored section. The cherries are not doing well. It was assumed that sour cherries would be a certain crop but a disease of unknown origin and unknown character has seized upon the roots and the base of the trunk of many of the cherry trees and their lives even are threatened. Plums have also suffered from diseases peculiar to that northern climate. The present experiments do not indicate that these two sorts of stone fruits are to play an important part in the fruit supply of the upper peninsula. Late sour cherries are produced in some considerable quantity about Marquette and it is hoped to secure trees that will withstand the rigors of the winter and will live to produce paying crops for many years.

The strawberry has succeeded at the station against all sorts of adverse conditions. Late frosts have caught them while in bloom and later when the fruit is fully formed, yet the yields have been surprisingly large. The aim is to secure late varieties which shall come into the market after the supplies from southern Michigan have been exhausted.

The trees at the South Haven Sub-station are now in full bearing and are teaching the lessons to be drawn from the battles of the varieties. In peaches the station has definitely pointed out the leading varieties which can be planted with certainty, to furnish a succession of fruit throughout the possible season. There are also extensive plantings of cherries, plums, and small fruits. The narrow boundaries of the area controlled by the station prevents more extended trials. The work already accomplished fits so admirably into the needs and present condition of the orchards in the fruit belt that no change in method or policy is recommended.

At the home station the work on the plots has been devoted largely to a study of the lessons taught by legumes. There have been investigations with sugar beets, with wheat, and with the cereals generally, but the emphasis has been laid upon legumes. Chief among these legumes has been, of course, alfalfa. Bulletin 225 attached to this report gives the results of the work. Alfalfa has been a treacherous crop rather more full of promise than of performance. It is not yet out of the experimental stage. It has been tried from Lake Superior to the Ohio line. In less than half of the cases has it succeeded, even for a single year. Cultural methods are being investigated and a true value determined for inoculation. Among the other prominent legumes studied were soy beans, cow peas and vetches. Part of the work with these important plants has been reported in bulletin 227. It is not at all probable that either soy beans or cow peas will ever become as prominent a field crop as clover or even as alfalfa, but, it is probable that they will find an extended use as green manures. The station has practically demonstrated that the amount of nitrogen to be furnished by one of these crops is dependent upon the number and vigor of the nodules on the roots.

As to vetches, the work to date has shown that it is a dangerous plant to introduce in fertile fields but that it will furnish a large amount of nitrogen when the roots are inoculated.

The work with sugar beets has been mainly directed toward the supply of better seed to the factories. At the harvest of 1902 certain mother beets were selected, first by their form and next, by the polariscope. Those that tested high in sugar are set out, in 1903, and from them seed was harvested. This seed was sown in 1904 and the resulting beets tested. It was found that the great majority of the mother beets did not produce seed which would in turn grow beets as rich as the mothers themselves. Naturally no mother beets were saved form the plots in which the average test was not as great or greater than the test of the mother beet which produced the seed. In a few cases the beets were fairly uniform in sugar content and the per cent was as high or higher than that of the mother beets. From these plots the mother beets were selected in the fall of 1904, for setting out in 1905.

In the meantime, the United States Department of Agriculture, donated to the station selected seed of several varieties for use in this work. These varieties were sown in the spring of 1904. In the fall of that year the plots were so harvested as to place all of the roots of a given variety side by side with the tops on. By making the first selection according to the type of root most prevalent on the plot it was found that the tops of these selected roots were quite similar and the form of top thus pointed out was taken as the type of the top for that variety. Practically all of the beets of typical form were pitted. In the spring of 1905 the pits were opened and the

roots subjected first to a test in a solution of common salt, generally a ten per cent solution. All the beets that floated in this solution were rejected. Those that sank were tested by boring a half-inch hole diagonally through the center of the beet from above downward. The core thus obtained was tested by the polariscope. The few beets which tested 19 per cent or above were set apart for a special plot. Next, those between 16.5 per cent and 19 per cent were set out in another plot and finally those testing above 16 per cent in a third plot. These plots were separated from each other to prevent cross fertilization. A record is kept of the pedigree of each beet and in some cases a record also of the form of the root and top. Sufficient seed will be produced in 1905 to make a somewhat extended test of it in comparison with imported seed.

The work on the Davenport plots still continues. The rotation experiment is peculiarly interesting and will reach definite conclusion in each of the next four years. It will be remembered that one series of these plots has been devoted to a test of the influence of rotation upon the yields and upon the fertility of the soil. It will be out of place in this report to mention some of the very interesting indications. Another series of plots is devoted to a comparison of fertilizers singly and in combination on yields and on the composition of the soil. It is proposed that beginning next winter all of the plots be planted to corn, the next year to oats, the third to wheat, and the fourth to clover, and that the appearance and yields of these crops be the guide as to the final effect of the rotations or the fertilizers.

The work in selecting improved strains of wheat was roughly interrupted by the adverse climatic conditions of 1903 and 1904. The work, however, is being continued, aimed to develop strains with better milling quality and giving better yields. In this connection samples of wheat of known origin were sent to a good many farmers, some on clay farms and others on sand, to test the influence of soil upon the composition of the wheat. Former experiments in another state had shown a very fundamental influence of the character of the soil on the quality of the grain. In that case it was spring wheat. We are carrying forward the same work with winter wheat on a slightly different plan.

The floods in the spring of 1904 and again in 1905 have stopped the very interesting series of experiments on muck, planned to discover not alone the best fertilizers for improving yield of crops for such soils, but also for improving the physical condition. The plots have been completely submerged for weeks in both years.

The departure of Professor Robison in the early spring of 1905, makes it necessary to omit the formal report from the head of that department. The work accomplished by the chemist covers the completion of a digestion experiment reported in special bulletin 32; the analyses of commercial fertilizers reported in a bulletin nearly ready for the press; an examination tion of soy beans, cow peas, alfalfa, vetch and clover as to chemical content in the work of determining their relative values as green manures and determining as well the influence of inoculation on the chemical composition of the entire plant and of the ripened seed; investigations of water and plants from the sandier sections of the state to aid in the solution of problems concerning the Grand Traverse disease of cattle.

After the departure of Professor Longyear, the work of the botanist was transferred to Professor R. H. Pettit, the entomologist, his previous ex-

perience in microscopy and in plant growing generally, having especially fitted him for the cryptogamic portion of the work. The examination of beet seeds in the early spring for several of the factories falls to the station and is now performed by Professor Pettit. A good deal of old beet seed is foisted upon the country and it is difficult to detect whether seed is new or old. It is possible that the decrease in per cent of germination may be an indication although that fact is not yet established. Farmers are coming more and more to look to the station for identification of plants and for advice about plants and the correspondence of the botanist seems to be increasing daily.

The year has been marked by the appearance of important bulletins from the entomological department. The loss to fruit growers brought about by the depredations of the codling moth, is enormous. The experiments and observations of Professor Pettit go far to suggest methods of fighting the pest which will greatly reduce this damage, since he has discovered the range of objects upon which the eggs are laid and has noted as well the time and material of successful spraying. The department is also doing a vast amount of good in replying to questions concerning all sorts of plant diseases and insect enemies.

In the live stock division of the station Professor Shaw has continued his studies with beet pulp raw and dried. He has also carried forward another year the work with fattening steers with silage, comparing results with other lots fed husked corn, ground, mixed with stalks or unhusked corn fed from the shock. The results have not been satisfactory and have partly contradicted the work of previous years, the steers fed silage showing neither a more rapid or more economical gain.

The veterinarian has been confronted with the disease of cattle on sandy soils and reports progress in the discovery of the cause.

The reports of the bacteriologist, chemist, horticulturist, entomologist, experimenter with live stock and veterinarian, are attached hereto and made part of this report.

Respectfully submitted,
C. D. SMITH,
Director of Experiment Station.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE HORTICULTURIST.

Prof. C. D. Smith, Director:

Sir—The work done during the past year by the Horticultural Department of the Experiment Station has included, in addition to the experiments carried on at the college and at the South Haven sub-station, a considerable amount of cooperative experiment work along various lines.

Professor U. P. Hedrick has continued in charge of the station orchards and the small fruit and vegetable plantations, and notes upon the behavior of the various crops have been furnished by his assistants, C. A. McCue and A. G. Craig.

The strawberry experimental plots in 1904 included a considerable number of English varieties obtained from Laxton Brothers, Bedford, England.

From the start these made a weak growth and produced a very small amount of fruit; in very few cases ranking above thirty on a scale of one hundred in either vigor or productiveness. Among the varieties tested were Aberdeen, August Nicaire, Bush Cluster, Climax, Dr. Hogg, Fillbasket, Elton Pine, Jas. Veitch, Jubilee, Royal Sovereign, Sir Joseph Paxton and Trafalgar. While ranking fairly high in quality, most of them are small in size, light in color and in flesh, and slightly lacking in firmness. With these many weaknesses there is little possibility that they will prove of value for this section of the country even for home use.

In addition to the above, one hundred and twenty varieties of American origin were tested. This list included a large number of the newer sorts, as well as many of the older and standard varieties in addition to a considerable number that were planted last spring but were not allowed to fruit. Among the more promising early sorts were Dewey, Excelsior, Hathaway, Haverland, and Springdale Beauty; Globe, Parson's Beauty, Mary, Sample, Pride of Cumberland, Shepherd and Stone were among the more productive mid-season sorts, while Benjamin, Bobolink, Enhance, Gandy, Mrs. McDowell, Nettie, Satisfaction and Wm. Belt made the best showing of the late sorts. A considerable number of kinds that were under trial, ordinarily compare favorably with most of those mentioned, but for various reasons proved less satisfactory last year. Among these sorts are Brandywine, Bubach, Clyde and Wolverton. The new varieties, Ben Davis and Downing's Bride are among the more valuable of the recent additions to the collection.

The recently discovered disease of the raspberry, known as cane-blight, made its appearance and did considerable harm in the raspberry plantation, especially upon some of the older planted varieties. The Turner and Loudon were among those least affected, but the last named sort was seriously injured by the crown gall. The Cumberland and Munger are among the more valuable of the blackcap varieties. Ridgeway, Haymaker and Brilliant are desirable, new, red varieties.

Of the currants, while Red Dutch, Versaillaise and Victoria are still very largely grown and generally successful, there are numerous other candidates for a place as commercial sorts to take the place of the Cherry and Fay, which have proven failures in most places owing to the injury from cane borers. Perhaps the most desirable is the Wilder. This slightly resembles its parent, Versaillaise, but the fruit is noticeably larger, and is borne on a stout, heavy and rather short fruit stalk. It is an early ripening and a very promising variety. Comet and Pomona are among the newer sorts. Neither of them have shown themselves very productive but the Comet in particular has very large berries and a mild, pleasant flavor.

The Perfection, a new sort originated by C. G. Hooker, of Rochester, New York, although not fully tested, bids fair to become one of the best varieties either for market or home use. The berries are very large and borne on long fruit stalks and are produced in great abundance. If the canes escape the attack of the borers, it will be likely to supersede the old sorts.

While the Downing gooseberry is now more commonly grown than all other sorts combined, the Pearl originated by Dr. Wm. Saunders, of the Central Experimental Farms, Ottawa, Ontario, seems to be equally valuable and in some cases surpasses it, being fully as hardy and productive, with a thinner skin and a tender, melting flesh which has a sweet, pleasant flavor

The Josselyn, which was introduced as Red Jacket, seems to be very productive and being of large size and having a pleasant, sub-acid, tender flesh, is a valuable sort either for home use or market. It seems to do especially well in cool, moist summers but even in dry weather, it can be kept free from the attack of mildew by one or two applications of liver of sulphur.

The trial plots of vegetables included a general assortment of beans, beets, cabbages, cauliflower, corn, egg plant, lettuce, peas, potatoes and tomatoes. While the list included a considerable number of new sorts, comparatively few of them excelled the carefully selected strains of the older varieties. It may be mentioned, however, that the Earliana as an extra early tomato is well worthy of first place, being of good size, globular and slightly flattened and quite productive. The flesh has a rich, pinkish red color and with thick cell-walls. The fruits are produced in clusters and seem to be quite free from the attack of rot. The Jewel as a second early sort will also take a high place. The fruits are regular, very solid and of a pleasant but acid flavor. This variety also seems comparatively free from rot.

A test of seventy-five varieties of potatoes was also made by Mr. Craig. They were given ordinary good care and, although the season was not favorable for large yields, gave fairly satisfactory results. Of the well-known early sorts Early Michigan produced 190.57 bushels per acre; Early Ohio 130.68 bushels; and White Ohio 191.78 bushels. The following were some of the more productive of the earlier kinds: Benaiah, 169.4; Cole's Early, 160.32; Coos No. 1, 173.03; Columbia, 184.52; Dewdrop, 175.45; Crine's Lighting, 134.37; Pioneer, 199.66; Silver Crown, 215.98; and Trumbull, 154.27 bushels per acre. Among the medium early kinds, Hewes produced 219.01 bushels; Irish Cobbler, 143.38 bushels; and Prince Edward, 154.27 bushels per acre. The following late varieties gave in bushels per acre: Coos No. 2, 257.12; Columbia, 210.54; Dewey, 202.67; Governor Yates, 187.55; Green Mountain, 302.5; Heavy Weight, 211.75; Home Comfort, 190.56; Million Dollar, 178.47; Michigan Beauty, 196.62; Red American Wonder, 278.30; Rural New Yorker, 278.32; Rose Beauty, 257.12; Sweet Home, 270.43; Sir Walter Raleigh, 294.63; Neshannock, 426.54.

There are several varieties that ordinarily make an excellent showing but last year the yield was smaller than was taken as the minimum for the varieties selected. Of the early varieties Triumph and Norther might be mentioned while of the late sorts, Carman No. 3, Maggie Murphy and Hiler's Choice have generally been included.

ORCHARD FRUITS.

The late spring frost destroyed the blossoms of the sweet cherries and only a small amount of fruit was set by the sour varieties. Early Richmond and Dyehouse were about the only kinds that yielded anything like a crop. The pear trees set a full crop of fruit but it was of rather an inferior grade, although it was quite free from the attack of insects and, with the exception of the White and Gray Doyenne, they were but little troubled by blight and other diseases. Only a moderate crop of apples was harvested. The scab was almost entirely controlled by spraying with Bordeaux mixture, but considerable damage was done by the second brood of the codling moth. Of the new varieties of apples fruiting, Nero should have special mention.

It is a large, late-keeping variety of a dark red color. The flesh is crisp and juicy and of very good quality.

All of the trees in the station orchards were sprayed three or four times with Bordeaux mixture and an arsenite during the season, except that from fifteen to thirty trees of each class of fruit were used for a comparative test of dust versus liquid applications. Seven applications of the dust spray were made, but in all cases the results were in favor of the liquid applications. This was especially noticeable so far as the codling moth of the apple and the curculio of the plum are concerned. Very little scab was noticed on either the apples or pears but, as all of the trees had received two applications of Bordeaux mixture in the spring before the applications of the dust spray were made, the result could not be entirely ascribed to it.

THE SOUTH HAVEN SUB-STATION.

The work at South Haven has continued in charge of Mr. T. A. Farrand and has been conducted along much the same lines as in previous years. The results so far as complete have been published in the annual report of the sub-station as Special Bulletin No. 30.

Considerable injury was done to the trees by the severe winter of 1903-04, especially to the peach trees that had come through the freeze of 1898-99. Most of them blossomed and started into growth in the spring and the full extent of the injury was not realized until later in the season. The loss was quite small in the cultivated orchards of the station as compared with many others in the vicinity that had received less care, especially if upon high or rolling land where the snow blew away so as to expose the roots.

Most of the trees in the older peach, plum and cherry orchards have produced several crops of fruit and have thus given some idea of the value of the different varieties. The apple and pear orchards planted from 1890 to 1895 are just beginning to produce full crops of fruit, although of course some of the varieties that naturally bear young have fruited for several years. In order to economize room the trees were planted one rod apart each way. By keeping the trees well headed back, this has answered fairly well up to the present time for all except the older apple trees. Most of these were planted so that it is possible to remove every other tree and still have at least one tree of a variety. The work of removing the duplicate trees where they are crowding badly was commenced last year in two of the apple blocks, but in the third block in which the trees are from twelve to fourteen years old, the experiment is being tried of growing the trees as dwarf standards by heading back the ends of the main branches during the month of June. This prevents the forcing out of water sprouts, but it at the same time promotes the development of fruit spurs and the results thus far have been quite satisfactory. While it is probable that one-half of the trees will have to be removed in the course of ten years, they will by that time be from twenty to twenty-five years old and will have produced quite a number of crops. As there are four trees upon the ground that would be occupied by one if the orchard was planted two rods apart and nearly six times as many as when the trees are forty feet square, there should be a considerable increase in the yield obtained.

The experiment with cover crops was continued last year but no new results were secured. The plots, however, were examined with much interest by the many visitors, and as most of them made a very satisfactory growth a considerable amount of humus was provided by all of them, as

well as a large amount of nitrogen where leguminous crops were sown. Mammoth clover made a much stronger growth than crimson clover which did not make a very good stand and was somewhat injured by the winter. While winter vetch made a slender growth in the fall and was of little value as a winter cover crop, it developed very rapidly quite early in the srping and covered the ground with a thick tangle which furnished an abundance of humus as well as nitrogen. This crop, however, has two serious drawbacks, first, it is very difficult to plow and turn under, as it can only be handled by using either a very sharp, rolling coulter, or by first working it down with a disc harrow; second, it may become a noxious weed if any of the plants are allowed to form seed. These are produced in great abundance and remain for a long time in the ground. Especially upon farms where grain is grown it cannot be safely used as an orchard cover crop and it is of no value as a forage crop as it does not seem palatable to most farm animals.

Various spraying experiments were carried on during the season. These in many respects duplicated the work done in previous years, but especial attention was given to a test of the effect of a late spray upon apple trees for the prevention of the attack of the second brood of the codling moth and of applications made to peach trees late in the fall for the prevention of leaf-curl. Very noticeable results were secured from an application made in early August in controlling the codling moth and, while the benefit from the fall application of copper sulphate in preventing leaf-curl was less marked than can be secured with spring applications, from the fact that many orchardists find their work so distributed that they can more readily give attention to the spraying in the autumn than in the spring, it will be of value to the owners of large peach orchards in the Lake shore districts, especially as high winds from the west generally prevail during the spring months, making thorough spraying at that time practically impossible.

CO-OPERATIVE EXPERIMENTS.

Several lines of horticultural experimental work have been carried on in various parts of the state during the year. Especial attention has been paid to the use of several of the more common remedies for the San Jose scale, with the idea not only of destroying the scale and at the same time learning the comparative merit of the different materials but that it should serve as a sort of object lesson for the people in the vicinity upon the benefits of spraying and the methods that should be pursued. Particular attention has been paid to the importance of first pruning the trees and of making sure that the spraying is very thorough. These points are too commonly overlooked by the average fruit grower and a failure to see that they have proper attention accounts for a majority of the instances where imperfect results have been reported.

Among the other co-operative experiments are several in connection with the use of Bordeaux mixture and various arsenites for the prevention of apple scab and to destroy the canker-worm and codling moth. Various cultural experiments with orchards have also been undertaken. These include the trial of different cover crops and methods of handling the orchards. In the main, the results with cover crops do not differ materially with those reported at the South Haven station, but they will have fully served their purpose if they merely call the attention of fruit growers in sections where the experiments are being carried on to their desirability and the compara-

tive merits of the different kinds. In the case of apple orchards, while the best growth of trees has been secured where regular cultivation has been given during the early part of the season, fairly good results have followed in a number of orchards where the trees are in sod but the grass has been cut and allowed to remain, or has been packed about the trees to serve as a mulch in young orchards.

The experiments with remedies for the San Jose scale have up to the present time shown nothing better than a winter application of the sulphur, lime and salt mixture prepared by boiling. When used upon a large scale, this work is simplified by employing steam for the purpose but if only a small quantity is required, the mixture may be cooked in a kettle or feed cooker. It answers fairly well, however, when the boiling is produced by slaking the lime in hot water, or by the chemical action produced by the addition of caustic soda.

Numerous patented mixtures have been tested during the past winter and spring, among them were "Con-Sol," "Kil-o-Scale," and "Anti-Scale." The former is said to be a concentrated form of the sulphur, lime and salt mixture, while the others are soluble petroleum compounds. Up to the present time, the results seem to be about equally beneficial from these mixtures, as very few live scales could be found two months after the applications were made. As a half-dozen scales left upon a tree will quickly re-infest it, the real benefit of the application cannot be determined until the second brood has developed. All of these remedies are readily prepared and, if they prove effectual, the only drawback to their use will be the cost, which ranges from three to six times that of the expense for materials required for the sulphur, lime and salt mixture.

Other experiments with fertilizers for orchards and various vegetable crops are under way, as are tests of fungicides for the control of potato blight and the diseases of cucumbers.

Respectfully submitted,
L. R. TAFT,
Horticulturist.

Agricultural College, Michigan, June 30, 1905.

REPORT OF THE CONSULTING VETERINARIAN.

Director C. D. Smith:

Dear Sir—During the past year as in previous years much of my work in this connection has been the answering of inquiries with regard to the various diseases of live stock. There have been no serious outbreaks of the contagious disorders. There seems to be much less trouble from the internal parasitic disorders of sheep than was experienced three or four years ago.

Circumstances over which we had no control, to a very great extent, destroyed the value of the work we had hoped to do in discovering a prevention for the so-called "Grand Traverse" disease. We hope to continue the work the coming year under more favorable circumstances. While the disease is confined to a comparatively small portion of the state, yet the

people of these portions feel their losses keenly, as the sections where the disease occurs are not the best from an agricultural standpoint.

Respectfully submitted,
GEO. A. WATERMAN,
Consulting Veterinarian.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE BACTERIOLOGIST.

To the Director of the Experiment Station:

There is much work which cannot be reported out this year, still it can be safely stated that no year previous has placed us in as favorable a position to do experimental work as this, owing largely to the adjustment to our new quarters and to the allowance of extra assistants.

It is customary to report upon work under investigation and state progress; but concerning such work I beg leave to refrain from saying a word, because I realize that many times it causes mischief and fails to contribute any good, and I invite critical investigation at any time. What can be discussed with perfect propriety and what has been accomplished may be considered with frankness.

The lines of work which have been completed sufficiently to warrant publication and those lines which are well under way but are not yet ready to give to the public may be best reviewed separately.

The manuscript for a bulletin, entitled "Extended Studies of the Associative Action of Bacteria in the Souring of Milk," is now ready for the press. In it are embodied the results of much work extending over a year, and taken together with two previous bulletins constitute our results upon "Associative Studies." How significant these technical studies are can be measured only by the future; even now, however, it is possible to point out their application with the limited knowledge and very meager experimental data at hand. The principal lines of application may be stated as (1) the importance of this knowlegde in the production of pure milk for consumption, a broader subject for my personal work for some years past, (2) the value in estimating the worth of starters in the making of butter and cheese, (3) saying nothing of the most evident fact, the keeping of milk. These facts are suggested and it is too early to enter into any discussion, for our enthusiasm at present may outweigh our wisdom.

This work will be continued, especially with the intention of ascertaining its practical bearing.

During the past year, but not really started until the year was considerably advanced, have been conducted by Messrs. Sackett and Clark some experiments in which they purpose to demonstrate the action of microorganisms in rendering soluble some of the insoluble constituents of the soil. They are nearly ready to publish a preliminary bulletin covering the results of their experiments to this time. Mr. Sackett and Mr. Tuttle expect to continue this line of investigation in the future.

Besides the above work of Messrs. Sackett and Clark, another field of investigation has been forced upon their attention through the revival of

enthusiasm over the tubercle bacteria associated with leguminous crops. In order to rationally present the matter to the farmers of Michigan, much work is necessary. It is unfortunate that this subject should reach the farming classes before it is firmly secured in its application by abundant experimentation; but the very excitement created may perhaps be the means of earlier conclusions. In the meantime, there will be many who will try inoculating and will fail; as a subsequent action these individuals will condemn through ignorance, which is the worst form of condemnation to counteract. The future will establish the worth of these soil or seed inoculations; the present should be devoted to detailed observations and very careful experimentation with suspended judgment. I am glad to report that Mr. L. T. Clark has prepared a bulletin in which will be given some facts and the present status of the work.

Mr. W. G. Sackett has prepared a bulletin of a popular character in which he calls attention to some of the bacterial diseases attacking plants. This has been called out by a general unfamiliarity with these diseases. Incidentally, in connection with his other work, Mr. Sackett is able to carry on limited studies with some of these diseases and he looks forward to a closer or more intimate knowledge of these troubles found in this state.

While Mr. Wright is not ready to report out any technical work, I am able to say that he is studying Michigan cheese and has already accumulated some data. It is hoped that by this work our knowledge will be more intimate and our respect greater for this highly prized article, so much praised and so much condemned, before it has passed into various mongrel forms through inbreeding and foreign admixture. It seems to me that it deserves consideration and its individuality should be maintained at least in part.

During the past year it has become apparent that there is a desire to know about the management and manipulation of starters. This is a somewhat difficult matter to explain, because it implies technical operations which are essential to complete success. Last winter Mr. Wright succeeded so well in presenting this subject to the short course students by laboratory methods which he has made practical that I have asked him to give his work in the form of a popular bulletin. This I shall take pleasure in presenting at the time of completion.

Some interest for the last two or three years has been manifested in the inhibitive action of fruit and vegetables upon germs, both from its bearing upon hygienic problems and from its significance in connection with their preservation. Dr. Wetmore has been studying this problem and has interesting data at hand, but she has not progressed to the extent where publication would seem warranted. There are valuable lessons to be secured from these studies and we trust that at least a preliminary statement will be possible at no distant date.

It will be seen from the foregoing that many thanks are due Messrs. Sackett, Wright, Clark, and Dr. Wetmore for their loyalty, patience, and persistency in the work of this department. It would also be unfair to neglect the contributing and most useful value of Mr. Parker. I take this opportunity to publicly acknowledge the gratitude of this department, and my personal gratification for being associated in work with them.

Respectfully submitted,

CHARLES E. MARSHALL,
Bacteriologist.

Agricultural College, Mich., June 30, 1905.

REPORT OF THE ENTOMOLOGIST.

Prof. C. D. Smith, Director:

Following is a brief report of the work done by the Division of Entomology during the year ending June 30, 1905, also of the work in botany since the appointment of the writer acting botanist.

One bulletin has been issued during the year, viz.: "The Codling Moth in Michigan." The work on mosquitoes was carried on during the latter half of the summer of 1904 with very gratifying results. The fish introduced in 1903 multiplied to such an extent that the numbers of the pests were reduced very noticeably, also many new breeding places were mapped and treated with oil, resulting in a marked abatement of the mosquito nuisance, inasmuch as almost all of the pests present on the campus came in from outside.

The work on the codling moth was completed and the results published in bulletin No. 222. One orchard is now under experimental condition in order to check up and prove the results once more.

Quite an extended course of experiments have been carried on during the last two years against greenhouse and forcing-house pests, with very good results; green-fly, chrysanthemum aphis, and the lice on lettuce have been controlled very cheaply without the nuisance and odor attendant on smoking. Several of the greenhouse scales have also been killed by means of sprays. The results of these and other experiments will be published at some time in the future in a bulletin on greenhouse and forcing-house pests.

A bulletin on garden insects is well started, after the plan of Special 24, on fruit insects. It will include results of a number of experiments made in our small experimental garden.

A number of pests new to the state have appeared during the past year, also some old enemies have made themselves conspicuous. Among these are an engraver beetle, which has attacked grape during the first part of the summer, namely *Xyleborus pyri*. This insect ordinarily attacks felled hardwood trees but occasionally works on fruits.

A nematode or thread worm in wheat threatened our fields but seems to have failed to withstand the vigorous spring growth.

The pale-brown *byturus*, *B. unicolor*, a small beetle about three-twentieths of an inch long, has attacked the flowers of our raspberries, and the strawberry weevil (*Anthonomus signatus*), has seriously injured the blackberry flowers in one locality.

Joint-worms (*Isosoma*) have worked in great numbers in grain all over the state.

The strawberry root-louse has recently made its appearance. This insect has come to stay, and one more serious enemy of the strawberry is now present in our state. It is usually indicated by the presence of ants in large numbers.

A tiny beetle, *Clivina impressifroms*, attacked the corn seed in the hill this year in one locality. So far as known to the writer, this is the second time that serious injury has been inflicted by this beetle. The first record comes from Indiana where Professor Webster found it at work.

Mole crickets, *Gryllotalpa borealis*, have added their quota to the injury to potato in damp mucky soil near Detroit.

Graphops pubescens appeared on grape leaves in quantity in one vineyard.

An unusual number of hair snakes have appeared in cabbages causing some little fear of poisoning by the so-called cabbage snake. It is unnecessary to add that such worms are entirely harmless.

A very destructive larva, new to the writer, appeared on strawberry roots. Specimens have been placed in cages in hopes of obtaining the adults.

The present wet season has proven very favorable to scale insects, especially those known as soft scales or Lecaniums. Great numbers are received daily on all sorts of host plants.

During the season the writer attended the Round-up Institute at Battle Creek as well as the winter meeting of the State Horticultural Society at Benton Harbor. Several trips have been made to different parts of the state to study special cases of insect trouble.

The botanical work has not been so extended nor has the correspondence been so voluminous, although it has taken up considerable time. The work has been, for the most part, confined to identification of plants sent in by correspondents, to weeds, fungous diseases, seed tests, etc.

During the year blue prints were made of the negatives, both botanical and those relating to insects. These were filed and systematized. This has made available a large amount of material for illustrating purposes. The Zeiss Photo-micrographic outfit has been extremely practical and useful in recording small insects, etc.

During the early part of the year the card catalog of references to Michigan insects has been brought nearly up to date, so far as was at first planned. All references to insects in the reports of the State Board of Agriculture as well as those in the reports of the State Horticultural Society have been entered on cards, making it possible to obtain easy access to this mass of material. So far as possible, references from other sources will be added as acquired, in hopes of making in time a nearly complete index of the insects of our state. It hardly seems necessary to mention the present cramped quarters occupied by this department or the lack of such facilities as insectary, photographic room, or space for collections as are desirable. It remains to thank the assistants who have done much to make the work of the department efficient. Mr. V. R. Gardner, a senior student, has been particularly helpful in every way, as has also Miss Katherine Gunn in systematizing the records, etc., and Mr. Moses Craig in botanical work. The writer wishes to convey his appreciation and thanks for their painstaking and careful aid.

Very respectfully submitted,

R. H. PETTIT,

Entomologist.

Agricultural College, Mich., June 30, 1905.

METEOROLOGICAL TABLES.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	18	22	10	100	100	100	29.023	29.012	29.059	22	5
2.......	9	12	0	100	100	100	28.964	28.962	29.126	13	-11
3.......	-3	16	7	100	100	100	29.298	29.213	29.245	11	-7
4.......	-6	12	3	100	100	100	29.376	29.370	29.368	12	-6
5.......	3	20	18	100	100	100	29.352	29.275	29.170	20	16
6.......	20	28	27	100	100	100	29.104	28.995	28.952	28	22
7.......	24	29	31	100	100	100	28.854	28.587	28.402	32	30
8.......	33	35	24	89	70	100	28.484	28.519	28.655	35	18
9.......	19	23	16	100	100	100	28.762	28.843	28.862	24	-2
10.......	2	17	18	100	100	100	28.900	28.880	28.872	18	15
11.......	16	22	17	100	100	100	28.892	28.935	28.980	22	14
12.......	17	22	20	100	100	100	28.947	28.890	28.774	23	15
13.......	16	24	21	100	100	100	28.704	28.702	28.712	25	19
14.......	24	26	19	100	100	100	28.743	28.807	28.958	27	14
15.......	16	21	23	100	100	100	29.064	28.967	28.855	23	22
16.......	28	20	14	100	100	100	28.679	28.795	28.928	30	8
17.......	9	13	7	100	100	100	29.311	29.325	29.431	15	-5
18.......	-4	13	9	100	100	100	29.577	29.515	29.446	15	-4
19.......	3	22	38	100	100	63	29.325	29.190	29.017	38	+3
20.......	35	38	29	100	100	100	29.067	29.005	28.993	38	35
21.......	29	32	31	100	100	100	28.836	28.690	28.619	32	27
22.......	27	31	28	100	100	100	28.387	28.452	28.534	32	25
23.......	24	20	12	100	100	100	28.783	28.780	28.858	25	23
24.......	-4	-3	-11	100	100	100	28.953	29.025	29.257	-1	-4
25.......	-13	8	-1	100	100	100	29.370	29.355	29.205	8	-15
26.......	1	12	2	100	100	100	28.947	29.042	29.158	12	-2
27.......	0	11	3	100	100	100	29.208	29.245	29.235	12	-2
28.......	2	16	3	100	100	100	29.276	29.241	29.260	18	-3
29.......	-1	16	-2	100	100	100	29.139	29.070	29.036	17	-5
30.......	11	24	18	100	100	100	28.827	28.837	28.823	26	-7
31.......	23	25	9	100	100	100	28.770	28.706	28.783	23	14
Sums....	378	622	443	3089	3070	3063	898.922	898.230	898.573	675	252
Means...	.....	.....	.....	100	99	99	....	....	....	......	......
Average..	.....	.....	.....	99			....	....	....	21.77	8.13

JANUARY, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
30	....	30	....	100	St.	w	..	n e	..	n e	..	....	....	....	......
100	Nim.	100	Nim.	20	....	n e	..	n	..	n w	..	....	....	....	......
30	....	10	....	10	Ci.	w	..	s w	..	w	..	....	....	....	......
5	St.	.....	....	15	St.	s e	..	s e	..	s	..	....	....	....	......
20	St.	20	St.	30	St.	s	..	s	..	s	..	....	....	....	......
100	St.	100	St.	100	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	w	..	n w	..	n w	..	....	....	....	......
100	St.	100	St.	100	St.	n w	..	n w	..	w	..	....	....	....	......
10	St.	100	St.	100	St.	e	..	e	..	e	..	....	....	....	......
100	St.	30	St.	100	St.	e	..	e	..	e	..	....	....	....	......
100	St.	100	St.	100	St.	e	..	e	..	s e	..	....	....	....	......
100	St.	100	St.	100	St.	w	..	w	..	w	..	....	....	....	......
100	St.	100	St.	60	St.	n w	..	w	..	n w	..	....	....	....	......
10	St.	100	St.	70	St.	s w	..	s e	..	s e	..	....	....	....	......
100	St.	80	St.	0	....	w	..	n w	..	n w	..	....	....	....	......
50	St.	0	....	0	....	n e	..	n e	..	n e	..	....	....	....	......
0	....	0	....	30	St.	n e	..	n e	..	n e	..	....	....	....	......
20	St.	100	St.	100	St.	s e	..	s	..	s w	..	....	....	....	......
100	St.	100	St.	100	St.	n e	..	e	..	n e	..	....	....	....	......
100	St.	100	St.	100	St.	n e	..	n e	..	n e	..	*	....	....	10.0
100	St.	100	St.	100	St.	n	..	n e	..	n	..	....	....	....	......
100	St.	100	St.	60	St.	s w	..	s w	..	s w	..	Snow	....	....	trace
0	....	60	Ci. St.	0	....	s w	..	s w	..	s w	..	†	....	....	1.0
30	St.	.....	....	100	St.	s w	..	s w	..	s w	..	....	....	....	......
100	St.	100	St.	20	St.	n e	..	n e	..	n w	..	Snow	....	....	2.0
40	St.	0	....	50	St.	s w	..	s w	..	s w	..	....	....	....	......
20	St.	0	....	0	....	s w	..	s w	..	n e	..	....	....	....	......
85	St.	0	....	0	....	n e	..	n e	..	e	..	Snow	....	....	trace
100	St.	100	St.	100	St.	s e	..	s	..	s w	..	Snow	....	....	1.0
100	St.	100	St.	10	St.	w	..	n w	..	n w	..	Snow	....	....	trace
2050	....	2030	....	1875	....	..	..	...	..	...	..	....	....	1.40	......
66	....	70	....	606	....	...	..	...	..	...	..	....	....	....	......
		65				...	..	...	..	...	..	....	....	....	......

*Snow and rain in night. †Snow all day.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	-8	8	2	100	100	100	28.907	28.980	28.915	8	-9
2.......	11	14	7	100	100	100	28.507	28.594	28.972	20	+2
3.......	3	8	0	100	100	100	29.087	29.156	29.218	8	+1
4.......	-2	10	5	100	100	100	29.248	29.188	29.113	10	-6
5.......	14	23	37	100	100	100	29.040	28.879	28.702	42	3
6.......	40	41	45	56	91	100	28.587	28.487	28.467	46	40
7.......	41	19	5	100	100	100	28.337	28.671	29.058	41	5
8.......	-2	4	0	100	100	100	29.321	29.355	29.451	4	-3
9.......	0	9	4	100	100	100	29.456	29.481	29.540	10	-1
10.......	-2	11	3	100	100	100	29.578	29.560	29.528	11	-3
11.......	2	13	7	100	100	100	29.521	29.465	29.411	14	-2
12.......	-1	11	7	100	100	100	29.421	29.360	29.313	12	-3
13.......	10	28	23	100	100	100	29.228	29.175	29.090	31	4
14.......	27	26	12	100	100	100	28.754	28.859	28.999	27	20
15.......	-2	-4	-10	100	100	100	29.027	29.072	29.198	-2	-10
16.......	-10	2	-3	100	100	100	29.261	29.265	29.315	2	-12
17.......	-10	3	7	100	100	100	29.428	29.430	29.410	7	-12
18.......	4	6	9	100	100	100	29.325	29.282	29.245	9	4
19.......	3	16	-2	100	100	100	29.338	29.345	29.410	17	-10
20.......	-3	22	20	100	100	100	29.492	29.448	29.401	22	-3
21.......	28	33	30	100	89	100	28.905	28.734	28.658	33	18
22.......	11	16	12	100	100	100	28.885	28.915	28.917	16	10
23.......	32	34	23	100	79	100	28.506	28.594	28.659	35	23
24.......	8	15	4	100	100	100	28.870	28.947	29.065	15	4
25.......	-6	12	9	100	100	100	29.291	29.290	29.248	13	-8
26.......	13	17	11	100	100	100	29.104	29.127	29.153	18	8
27.......	5	29	31	100	100	100	29.271	29.014	28.972	31	-2
28.......	35	38	35	100	100	100	28.903	28.921	29.024	40	35
29.......	33	35	28	100	100	100	28.902	28.778	28.846	35	23
Sums....	274	499	356	2856	2859	2900	843.500	843.372	844.298	575	116
Means...	.....	.....	.....	98	99	100	....	....	....	1983	4.00
Average..	.....	.....	.....		99		....	....	....	......	15.83

FEBRUARY, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
0		0		0		n w		n w		s e		*			1.0
100	St.	90	St.	0		s e		s w		w		Snow			trace
15	St.	100	St.	0		s w		s w		n w		Snow			1.0
95	St.	60	St.	20	St.	s w		s w		s w					
100	St.	100	St.	100	St.	s e		s e		s w		*		0.5	
100	St.	100	St.	100	St.	s w		s w		s					
100	St.	100	St.	5	St.	s w		n w		n w		*		1.0	trace
0		20	St.	0		n w		n w		n w					
25	St.	10	St.	0		n e		n e		n e					
0		0		0		n e		n e		n e					
0		30	St.	100	St.	n e		n e		n e		Snow			0.5
0		0		0		n		n e		n e					
100	St.	100	St.	100	St.	s e		n e		n		Snow			0.5
90	St.	85	Ci. St.	10	St.	n w		n		n					
5	St.	80	St.	0		n w		n w		w					
0		5	St.	0		w		n w		n w					
0		0		60	St.	n e		n e		s e					
100	St.	100	St.	100	St.	e		n e		n					3.0
0		0		0		n w		n e		e					
0		0		60	St.	s e		s e		s e					
100	St.	100	St.	100	St.	s e		s		s w					
100	St.	0		100	St.	s w		s w		s w					6.0
100	St.	100	St.	100	St.	s w		s w		n					2.0
100	St.	50	St.	0		n w		n w		n w					
10	Ci.	50	Ci. St.	90	St.	n w		n		e					
80	St.	70	Ci. St.	0		s e		e		n e					
20	Ci. St.	70	St.	90	St.	s e		s		s					
100	St.	90	St.	100	St.	w		s		e					1.0
100	St.	100	St.	100	St.	e		e		n w				.30	trace
1540		1610		1335										3.30	
53		56		46											
		52													

*Snow in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering Thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	24	26	32	100	100	100	29.063	29.075	29.038	32	22
2.......	32	42	45	100	100	100	28.937	28.697	28.388	45	21
3.......	12	20	11	100	100	100	28.722	28.892	29.255	22	11
4.......	14	28	23	100	100	100	29.357	29.408	29.387	28	8
5.......	27	39	37	100	100	100	29.255	29.200	29.110	39	19
6.......	37	38	38	100	100	100	28.953	28.954	28.776	38	35
7.......	35	36	34	100	100	100	28.632	28.622	28.678	36	34
8.......	32	35	26	100	100	100	28.780	28.832	28.899	37	30
9.......	22	34	29	100	100	100	29.067	29.099	29.080	36	18
10.......	28	33	27	100	89	100	28.918	28.940	28.802	35	17
11.......	29	26	23	100	100	100	28.668	28.670	28.732	29	21
12.......	18	21	17	100	100	100	28.988	28.985	29.009	23	17
13.......	19	29	24	100	100	100	29.070	28.987	28.868	31	10
14.......	22	24	22	100	100	100	28.655	28.647	28.752	26	21
15.......	21	27	28	100	100	100	28.845	29.058	29.058	28	19
16.......	23	29	26	100	100	100	29.296	29.315	29.323	30	21
17.......	25	28	28	100	100	100	29.246	29.062	28.821	28	22
18.......	25	38	34	100	100	100	28.908	28.825	28.871	39	23
19.......	32	39	27	100	100	100	28.818	28.812	28.865	41	25
20.......	21	27	23	100	100	100	29.161	29.159	29.093	30	16
21.......	27	40	38	100	100	100	29.066	28.832	28.624	41	20
22.......	47	50	32	100	93	100	28.677	28.845	29.053	52	30
23.......	32	49	37	100	100	100	29.214	29.255	29.296	51	26
24.......	39	55	48	100	93	100	29.206	29.120	28.958	55	33
25.......	52	54	50	100	100	100	28.858	28.770	28.808	54	44
26.......	23	24	20	100	100	100	28.927	29.045	29.057	25	20
27.......	18	22	18	100	100	100	29.130	29.107	29.088	24	14
28.......	22	34	32	100	100	100	29.073	29.058	29.035	35	17
29.......	35	48	45	100	100	100	29.020	28.949	28.942	49	30
30.......	40	47	45	100	100	100	28.937	28.860	28.767	48	38
31.......	45	62	51	100	88	100	28.697	28.727	28.735	64	39
Sums....	878	1104	970	3100	3063	3100	898.144	897.807	897.168	1151	721
Means...	.....	.....	.....	100	99	100	....	....	....	37.13	23.26
Average..	.....	.....	.....		100		....	....	....	......	13.87

MARCH, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	100	St.	w	..	s w	..	s	..	......	......	......	......
10	Ci.	100	St.	100	St.	s	..	s e	..	s	..	*	......	.50	......
100	St.	80	St.	0	......	n w	..	n w	..	w	..	......	......	......	......
20	St.	30	St.	80	St.	s w	..	s w	..	s w	..	......	......	......	......
80	St.	100	St.	100	St.	s e	..	s e	..	s e	..	......	......	......	......
100	St.	100	St.	100	St.	s e	..	e	..	s e	..	†	......	.60	......
100	St.	100	St.	100	St.	s w	..	w	..	w	..	......	......	......	......
15	St.	10	St.	0	......	n w	..	n w	..	n w	..	......	......	......	......
20	Ci. St.	20	St.	80	St.	n w	..	n w	..	n e	..	......	......	......	......
100	St.	85	St.	100	St.	s e	..	e	..	n e	..	Night	......	trace	......
100	St.	100	St.	100	St.	n	..	n w	..	n	..	‡	......	trace	trace
100	St.	100	St.	60	St.	n e	..	n e	..	n e	..	......	......	......	......
0	......	10	Ci.	90	St.	n e	..	n e	..	n e	..	......	......	......	......
100	St.	100	St.	100	St.	n e	..	n e	..	n e	..	Snow	......	......	9.0
20	St.	100	St.	100	St.	n e	..	n e	..	n w	..	......	......	......	......
100	St.	100	St.	100	St.	n w	..	n w	..	n w	..	......	......	......	......
100	St.	100	St.	100	St.	s e	..	s e	..	n e	..	§	......	......	5.0
100	St.	85	St.	100	St.	n w	..	s w	..	s	..	......	......	......	......
100	St.	65	St.	30	St.	s	..	s w	..	w	..	Night	Day	0.20	......
0	......	0	......	50	St.	n w	..	n e	..	n e	..	......	......	......	......
100	St.	100	St.	100	St.	n e	..	s e	..	s e	..	‖	......	0.10	......
90	St.	90	St.	0	......	s	..	s w	..	w	..	......	......	......	......
0	......	10	Ci.	0	......	w	..	s w	..	s	..	......	......	......	......
10	Ci.	15	Ci. St.	60	St.	s e	..	s e	..	s e	..	‖	......	0.60	......
90	St.	100	St.	100	St.	s w	..	s w	..	s w	..	......	......	......	......
100	St.	100	St.	60	St.	n w	..	w	..	n w	..	Snow	......	......	trace
50	St.	80	St.	100	St.	n w	..	n w	..	n w	..	Snow.	......	......	.5
15	St.	40	Cu. St.	90	St.	s w	..	s w	..	s	..	......	......	......	......
95	St.	50	St.	30	St.	s	..	s	..	s	..	......	......	......	......
100	St.	100	St.	100	St.	s e	..	s e	..	s e	..	8 p. m.	Night.	......	.1
100	St.	80	Ci. St.	100	St.	s e	..	s e	..	s	..	......	......	......	......
2115	......	2250	......	2330	......	...	..	...	..	...	..	......	......	3.46	......
68	......	73	......	75	......	...	..	...	..	...	..	......	......	......	......
		72				...	..	...	..	...	..	......	......	......	......

*Severe thunder storm in night. †Day and night. ‡Rain and snow. §Snow 10 a. m. ‖Light snow in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	41	44	40	100	92	100	28.726	28.840	28.845	45	38
2.......	34	35	30	100	100	100	28.945	29.000	29.093	39	22
3.......	25	34	28	100	100	100	29.360	29.390	29.451	35	23
4.......	32	48	35	100	85	100	29.488	29.465	29.321	49	23
5.......	38	55	46	100	93	100	29.275	29.185	29.095	56	31
6.......	40	50	43	100	100	100	28.965	28.928	28.911	51	38
7.......	36	58	46	100	88	100	28.973	28.980	28.913	59	31
8.......	46	46	42	100	100	100	28.582	28.604	28.648	57	39
9.......	45	45	34	100	100	100	28.449	28.469	28.407	46	21
10.......	35	37	33	100	100	100	28.500	28.549	28.599	45	42
11.......	35	45	36	100	100	100	28.635	28.660	28.702	37	32
12.......	32	36	28	100	100	100	28.814	....	....	45	30
13.......	26	35	32	100	100	100	29.013	28.992	28.978	36	26
14.......	29	39	34	100	100	100	28.963	28.958	28.965	40	22
15.......	32	30	25	100	100	100	28.892	28.820	28.868	33	21
16.......	18	27	24	100	100	100	29.262	29.260	29.275	31	15
17.......	33	46	34	89	92	100	29.178	29.058	28.992	47	20
18.......	37	50	32	100	93	100	28.937	28.938	28.936	53	32
19.......	28	28	24	100	100	100	29.098	29.151	29.241	30	23
20.......	23	38	31	100	100	100	29.249	29.256	29.274	40	18
21	31	48	36	100	93	100	29.383	29.345	29.327	50	23
22.......	37	50	44	100	93	100	29.301	29.211	29.166	52	28
23.......	48	75	52	100	90	100	29.095	29.007	28.900	78	46
24.......	65	65	50	100	100	100	28.720	28.765	28.881	67	50
25.......	42	46	43	100	100	100	28.906	28.872	28.871	47	40
26.......	37	48	41	100	100	100	28.958	28.985	29.023	49	36
27.......	42	53	46	100	100	100	29.082	29.062	29.095	55	35
28.......	46	56	48	100	94	100	29.060	28.995	28.945	60	37
29.......	48	62	50	100	94	100	28.900	28.892	28.847	66	44
30.......	46	55	49	100	100	100	28.842	28.863	28.868	56	38
Sums....	1107	1384	1136	2989	2907	3000	840.737	840.500	840.437	14.54	9.24
Means...	.....	.....	.....	100	97	100	....	....	....	48.47	30.80
Average..	.....	.....	.....		99		....	....	....	......	17.67

APRIL, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	90	St.	n w	..	w	..	s w	..				
100	St.	100	St.	100	St.	w	..	n w	..	n w	..				
0		0		0		n	..	n e	..	...	..				
0		0		0		s w	..	s w	..	s w	..				
5	Ci.	0		0		s	..	s w	..	s	..				
100	St.	100	St.	100	St.	s e	..	s w	..	...	..				
70	St.	15	St.	0		e	..	e	..	s e	..				
100	St.	....		100	Nim.	e	..	s e	..	s e	..	9:30 am	1 p. m.		
90	St.	50	Cu.	100	St.	s e	..	s e	..	s w	..	Night			
90	Nim.	100	St.	80	Cu.	w	..	s w	..	s	..				
30	St.	50	Cu.	80	Cu.	s e	..	s w	..	w	..	Snow		trace	
100	Cu.	50	Cu.	0		n w	..	n	..	n	..	*			
0		60	Cu.	30	St.	w	..	w	..	w	..				
100	St.	90	St.	0		s w	..	w	..	...	..	Snow			trace
100	St.	100	St.	100	St.	s e	..	s e	..	n e	..	6 a. m.	3 p. m.		6.5
0		0		0		n w	..	n w	..	n w	..				
0		20	Ci.	0		s	..	w	..	s w	..				
95	St.	40	Cu.	100	St.	s w	..	s w	..	n w	..	Night			trace
70	Cu.	100	St.	10	St.	n	..	n	..	n	..				
0		0		0		n	..	n	..	...	..				
0		0		0		n e	..	n e	..	e	..				
5	Ci.	0		100	St.	s e	..	s e	..	e	..	4 a. m.	9 a. m.	.15	
10	Ci.	20	Cu.	10	Ci.	s w	..	s	..	s	..				
100	St.	90	Cu.	0		s	..	w	..	n	..				
100	St.	100	St.	95	St.	n e	..	n e	..	n e	..				
100	St.	20	Ci.	50	St.	n e	..	n e	..	n	..				
0		20	Ci.	20	Ci.	n e	..	n e	..	n e	..				
0		90	St.	85	St.	n e	..	n e	..	n e	..				
75	St.	50	St.	100	St.	n w	..	n e	..	n e	..	Night.		trace	
100	St.	100	St.	100	St.	n e	..	n e	..	n e	..				
1640		1465		1450											
55		51		48											
		51													

*10:30 snow in night.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	56	62	48	100	94	100	29.008	29.027	29.082	64	46
2.......	54	69	51	100	90	100	29.151	29.160	29.181	71	40
3.......	53	73	59	100	95	100	29.222	29.225	29.228	75	39
4.......	59	72	59	100	90	94	29.236	29.231	29.156	74	48
5.......	60	75	63	94	77	78	29.154	29.092	29.070	77	50
6.......	65	75	56	78	77	81	29.040	28.987	28.918	77	54
7.......	69	76	62	75	86	83	28.860	28.790	28.732	81	54
8.......	67	74	65	79	95	100	28.640	28.524	28.439	77	52
9.......	46	58	46	100	100	100	28.462	28.579	28.855	58	45
10.......	42	48	40	83	100	100	28.977	29.002	29.111	50	35
11.......	.....	.....	42	.....	.....	91	....	....	....	60	30.5
12.......	58	74	63	82	81	100	28.996	28.970	28.925	74	57
13.......	65	67	50	73	100	100	28.828	28.787	28.808	67	40
14.......	47	56	44	100	100	100	28.841	28.802	28.816	58	38
15.......	38	46	41	100	100	100	28.879	28.878	28.888	47	33
16.......	43	55	46	83	93	100	28.922	28.898	28.903	56	31
17.......	50	58	48	93	88	93	28.890	28.880	28.858	61	36
18.......	44	48	49	100	100	100	28.816	28.730	28.668	50	40
19.......	51	55	52	100	100	100	28.602	28.584	28.644	55	43
20.......	57	70	58	94	85	88	28.872	28.940	29.010	73	50
21.......	62	77	64	77	75	89	29.033	29.055	29.068	79	49
22.......	66	76	68	79	91	100	28.845	28.712	28.607	79	59
23.......	65	74	54	94	86	93	28.662	28.802	28.908	76	58
24.......	58	71	64	82	85	94	29.005	29.022	28.975	72	46
25.......	74	82	71	86	83	85	28.870	28.794	28.702	85	56
26.......	73	66	48	81	100	100	28.717	28.658	28.663	76	67
27.......	54	76	58	87	82	94	29.003	29.025	29.040	78	43
28.......	61	73	60	77	81	82	29.073	29.097	29.098	74	52
29.......	64	78	60	73	91	88	28.958	28.815	28.852	79	55
30.......	58	62	53	100	88	86	28.958	28.957	28.925	65	56
31.......	57	62	55	75	87	93	28.948	28.918	28.925	64	44
Sums....	1716	2008	1655	2645	2700	2912	867.468	866.941	867.055	2132	1446
Means...	.....	.....	.....	88	90	94	....	....	....	68.77	46.66
Average..	.....	.....	.....		91		....	....	....	......	22.11

MAY, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	50	St. Cu.	5	St.	n e		n e		e					
0		0		5	St.	s e		s e		e					
0		15	Cu.	0		e		e		s e					
0		20	Cu.	0		s e		s e		s					
0		30	Cu.	0		...		s		s					
0		35	Cu.	0		s		s		s					
15	Ci.	25	St. Ci.	0		s		s		s					
70	Ci. St.	90	St.	60	St.	s		s		s					
100	St.	90	St.	0		n w		n w		w				.12	
50	St.	100	St.	0		n w		n w		w					
				30	Cu.	...		...		s e		*			
100	Cu.	40	St.	0		s		s		s		Night		trace	
80	Ci. St.	100	Nim.	100	Cu.	s		s		s		10 a. m.	Night	.20	
10	St.	90	St.	100	St.	s		s		s		Night		.13	
80	St.	100	St.	100	St.	s w		w		w		5:30p.m.	7 p. m.	.08	
5	St.	100	St.	0		s w		s w		s w					
35	Ci.	0		0		s		s w		w					
100	St.	100	St.	100	St.	n w		n w		n w		†			
100	St.	100	St.	100	St.	n w		n w		n w			6 p. m.	1.36	
90	St.	40	Cu.	0		n		n w		n w					
0		0		100	St.	w		w		w					
20	Ci.	90	St.	100	St.	w		s w		s w		Shower	Night	.31	
75	Ci. St.	70	St.	0		s w		s w		s w					
0		100	St.	0		s w		s w		s w					
25	Ci. St.	20	Ci. St.	15	Ci. St.	s w		s w		s w					
35	Ci. St.	100	St.	100	St.	s w		s w		s w		11:00	3:30	.11	
0		10	Ci.	0		w		w		w					
0		10	St.	0		s w		s w		s w					
90	St.	100	St.	100	St.	s w		s w		s w					
100	Nim.	80	St.	80	St.	n		n w		n		Night	11 a. m	.09	
0		100	St.	100	St.	n e		n e		n e					
1280		1805		1195										2.40	
43		60		39											
		47													

*Heavy frost. †11:30 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	52	62	58	86	88	94	28.933	28.933	28.928	63	49
2.......	56	66	59	100	84	88	28.918	28.918	28.923	67	51
3.......	66	78	68	84	82	84	28.900	28.892	28.915	81	54
4.......	71	79	72	85	82	85	28.925	28.927	28.922	81	64
5.......	69	76	60	90	82	88	28.830	28.837	28.850	79	67
6.......	60	67	54	94	89	87	28.870	28.872	28.890	69	55
7.......	56	63	56	87	94	100	28.898	28.915	28.923	63	49
8.......	54	62	58	100	88	94	28.951	28.972	28.998	64	52
9.......	62	71	61	88	85	94	29.095	29.108	29.133	73	54
10.......	55	70	62	100	80	88	29.164	29.161	29.158	72	53
11.......	62	78	65	77	82	89	29.164	29.185	29.206	79	50
12.......	60	84	69	82	79	85	29.176	29.140	29.115	86	56
13.......	70	82	69	90	79	70	29.107	29.042	29.000	84	58
14.......	61	74	63	94	76	83	28.962	28.962	28.967	77	59
15.......	59	70	56	82	80	87	28.998	29.012	29.058	72	56
16.......	57	71	55	75	75	81	29.151	29.125	29.125	73	48
17.......	63	78	61	62	73	77	29.135	29.097	29.098	80	47
18.......	70	83	61	75	71	77	29.078	29.032	29.045	86	52
19.......	63	80	67	67	59	89	29.030	28.929	28.938	83	58
20.......	67	80	63	89	70	78	28.857	28.827	28.815	83	61
21.......	64	74	60	83	72	88	28.843	28.867	28.913	76	56
22.......	53	70	58	86	85	88	29.005	29.032	29.078	73	50
23.......	64	79	71	78	58	75	29.130	29.077	29.030	81	50
24.......	76	77	76	82	100	100	29.017	28.967	28.974	88	62
25.......	74	78	77	95	91	82	28.974	28.912	28.892	81	67
26.......	66	73	61	89	72	94	29.040	29.092	29.168	76	61
27.......	60	70	59	88	80	82	29.233	29.155	29.102	72	53
28.......	62	69	66	88	90	89	29.015	28.892	28.822	73	47
29.......	69	67	64	90	89	94	28.752	28.715	28.647	74	60
30.......	66	75	61	95	77	94	28.690	28.662	28.702	76	54
Sums....	1887	2206	1890	2581	2412	2604	869.841	869.257	869.335	2285	1653
Means...	.....	.....	.....	86	80	87	....	....	....	76.17	55.10
Average..	.....	.....	.....	84			....	....	....	......	21.07

JUNE, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	100	St.	n e	..	n e	..	n e	..				
100	St.	100	St.	80	St.	s w	..	s e	..	s e	..				
15	Ci.	10	Ci.	30	St.	s e	..	s	..	s	..				
40	St.	30	Cu.	0		s	..	s	..	s	..				
100	St.	15	Cu.	0		s	..	s	..	s w	..				
100	St.	100	St.	100	St.	s w	..	s w	..	s w	..				
100	St.	100	St.	100	St.	s w	..	s w	..	n w	..				
100	St.	90	St.	50	St.	w	..	n w	..	n w	..	Night	9 a. m.	.04	
0		15	Ci.	0		n	..	n e	..	n e	..				
100	St.	15	Cu.	0		n e	..	n	..	n e	..				
0		0		0		n e	..	n e	..	n e	..				
0		10	Cu.	5	St.	n e	..	e	..	e	..				
5	Ci.	20	Cu.	0		s w	..	s w	..	s w	..				
90	Ci. St.	15	Ci.	0		s e	..	s e	..	s e	..	5:30 am.	6:30 am.	.04	
20	Ci.	15	Ci. St.	0		s w	..	s w	..	s w	..				
15	Ci.	0		0		n e	..	n e	..	e	..				
0		0		0		s e	..	s e	..	...	..				
0		0		0		w	..	s w	..	s w	..				
10	Ci.	15	Ci.	40	St.	s	..	s	..	s e	..				
90	St.	60	St.	35	St.	s w	..	s w	..	s w	..				
60	St.	20	Cu.	0		w	..	w	..	w	..				
100	St.	40	Cu.	0		n	..	n	..	n e	..				
10	Ci.	60	Ci. St.	0		s e	..	s	..	s	..				
15	Ci. St.	95	St.	30	St.	s	..	n e	..	n e	..	*	7:30	1.57	
30	St.	90	St.	10	Ci.	s w	..	s w	..	s w	..	2:30	4:00	.55	
15	Cu.	25	Ci.	95	St.	s w	..	w	..	...	..				
80	Ci.	30	Ci.	40	Ci. St.	n e	..	s e	..	s e	..				
20	Ci. St.	100	St.	100	St.	e	..	s e	..	s e	..				
10	St.	90	St. Cu.	100	St.	s	..	s w	..	s w	..	†	‡	17,12	
80	Cu. St.	70	Cu. St.	0		s w	..	w	..	...	..				
1405		1330		915		...	..	...	..	...	..			2.49	
47		44		31		...	..	...	..	...	..				
		41				...	..	...	..	...	..				

* 12:30 showers.
† 12:30, 7:30.
‡ 1:30, 9:00.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air. 7 A. M.	2 P. M.	9 P. M.	Relative humidity or per cent of saturation. 7 A. M.	2 P. M.	9 P. M.	Barometer reduced to freezing point. 7 A. M.	2 P. M.	9 P. M.	Registering Thermometer Maximum.	Minimum.
1.......	58	60	58	88	94	94	28.865	28.930	29.025	62	56
2.......	58	71	52	82	71	93	29.179	29.171	29.204	73	45
3.......	63	72	67	83	80	84	29.211	29.117	29.002	76	47
4.......	73	71	66	85	100	100	28.825	28.830	28.925	76	65
5.......	73	81	73	85	74	95	28.967	28.939	28.960	83	60
6.......	62	77	71	94	77	100	28.968	28.967	28.990	78	61
7.......	61	75	69	100	86	95	29.013	28.995	28.997	78	59
8.......	69	79	70	85	82	100	29.010	28.892	28.877	80	58
9.......	66	73	67	100	95	100	28.900	28.827	28.865	76	65
10.......	.....	82	.....	......	......	......	28.832	28.767	28.777	......	......
11.......	74	82	.....	81	75	......	28.742	....	....	84	80
12.......	.....	72	61	......	54	71	....	....	....	......	......
13.......	69	80	64	65	59	94	28.940	28.914	28.970	80	51
14.......	67	78	73	79	69	81	29.005	28.884	28.857	81	59
15.......	73	81	72	76	67	85	28.912	28.932	28.970	82	59
16.......	75	.....	.....	68	......	......	29.012	....	....	91	57
17.......	.....	90	.....	......	......	......	....	....	....	93	69
18.......	.....	.....	.....	......	......	......	....	....	....	94	65
19.......	80	.....	.....	74	......	......	....	....	....	88	54
20.......	76	.....	68	64	......	90	....	....	....	86	58
21.......	70	79	66	80	70	84	28.950	28.879	28.890	80	56
22.......	69	60	56	85	94	94	28.879	28.887	28.942	77	51
23.......	63	68	58	83	84	88	29.018	29.042	29.098	70	54
24.......	67	75	61	84	64	88	29.143	29.092	29.092	77	47
25.......	67	77	63	84	69	94	29.128	29.065	29.101	81	54
26.......	66	80	66	79	59	95	29.078	28.982	28.982	83	56
27.......	67	76	66	95	91	95	28.987	28.914	28.940	81	61
28.......	65	71	62	78	75	88	28.987	29.007	29.017	75	59
29.......	60	77	65	88	69	84	29.108	29.080	29.075	79	49
30.......	65	79	79	100	74	87	28.995	28.892	28.844	80	61
31.......	70	82	79	95	71	95	28.847	28.849	28.894	83	69
Sums....	1521	1722	1523	2260	1903	2274	682.747	694.854	695.294	2327	1685
Means...	.....	.....	.....	84	76	91	....	....	....	80.24	58.10
Average..	.....	.....	.....		84		....	....	....	......	22 14

JULY 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	90	St.	w		n w		n w					
0		60	Cu.	0		w		n w		n w					
15	Ci.	85	Ci. St.	5	St.	s e		s		s					
95	St.	100	St.	10	St.	s		w		w		*1:00	*2:00	.09	
0		30	Cu.	15	St.	w		s w		n w					
100	St.	10	Ci. Cu.	100	St.	e		n		n		8 p. m.		.03	
90	St.	95	St. Cu.	10	St.	n		n e		n e			Night	.12	
20	Ci.	10	Cu.	0		e		s e				3:30	4:30	.05	
100	St.	100	St.	80	St.	s w		s w		s w		Night	8:30	1.09	
100	Cu.	100	Cu.	100	Cu.	s w		s w		s w					
50	Cu.	60	Cu.	0								Night		.59	
0		0		0		n		n		n					
0		40	Cu.	0		s		w							
95	St.	85	St.	0		s		s		s					
0		0		0		s		w		w					
0						w									
						s w									
0			0			n e				n w					
0		35	Cu.	35	Ci. St.	n w		w							
30	Ci.	95	St. Cu.	0		e		n w		n					
10	Ci. St.	80	St. Cu.	0		n		n		n					
20	Cu.	55	Cu.	0		n e		n							
10	Ci.	65	Cu.	10	Cu.	n w		s w		s					
0		90	Cu. St.	100	St.	w		s w		s e					
0		100	St.	100	St.	s		s		s w					
5	St.	5	St.	30	Cu.	n e		n e							
25	Ci.	50	Ci.	10	St.	n e		n e		e					
100	St.	100	St.	90	St.	s		s		s					
100	St.	35	Ci.	25	Ci. St.	s w		s w		s w		7:30 am.	9 a. m.	trace	
1065		1585		810										1.97	
38		59		30											
		42													

* Showers.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1	65	79	63	89	66	94	28.952	28.939	29.005	81	58
2	59	71	59	76	75	100	29.090	29.070	29.080	73	55
3	62	80	61	88	74	94	29.095	29.050	29.040	80	46
4	67	84	74	79	61	81	29.010	28.899	28.854	85	56
5	70	79	66	80	66	89	28.925	28.889	28.887	81	59
6	67	74	64	84	63	83	28.830	28.827	28.830	76	61
7	71	72	50	71	62	100	28.835	28.852	29.021	77	52
8	51	69	56	86	80	100	29.167	29.176	29.236	70	43
9	61	80	71	71	55	75	29.216	29.072	29.005	82	49
10	63	69	56	100	95	100	29.015	28.995	29.098	72	61
11	56	73	56	94	72	94	29.206	29.198	29.221	75	51
12	61	78	66	86	69	95	29.244	29.158	29.065	80	50
13	72	83	.....	.....	79	.....	28.887	28.894	28.922	86	60
14	66	.....	.....	.....	.....	.....	28.940	.....	.....	85	47
15	.....	82	.....	.....	67	.....	.....	.....	.....	82	55
16	70	.....	.....	79	.....	.....	.....	.....	.....	84	55
17	.....	.....	.....	.....	.....	.....	.....	.....	.....	80	53
18	.....	.....	.....	.....	.....	.....	.....	.....	.....	86	60
19	66	.....	.....	79	.....	.....	.....	.....	.....	81	51
20	67	.....	.....	95	.....	.....	.....	.....	.....	68	57
21	80	.....	.....	82	.....	.....	.....	.....	.....	83	59
22	64	69	56	100	80	94	28.935	29.100	29.223	71	61
23	58	73	62	88	81	88	29.306	29.225	29.173	75	46
24	63	79	69	83	66	80	29.143	28.977	28.915	80	54
25	74	76	56	90	64	94	28.752	28.810	28.995	78	67
26	61	71	56	82	75	87	29.204	29.148	29.166	73	44
27	58	74	61	82	72	94	29.186	29.165	29.169	75	48
28	64	78	63	78	73	83	29.080	29.042	29.017	80	51
29	59	61	56	82	94	94	29.125	29.122	29.154	64	53
30	54	72	.....	87	80	.....	29.146	29.085	29.103	73	49
31	.....	.....	.....	.....	.....	.....	.....	.....	.....	76	53
Sums	1254	1489	1221	2111	1669	1819	639.349	638.693	639.179	2412	1664
Means	.....	.....	.....	84	73	91	.....	.....	.....	77.81	53.68
Average	.....	.....	.....		83		.....	.....	.....	.....	24.13

AUGUST, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
10	Ci.	20	Cu.	80	Cu.	s w	..	w	..	n	..	....	....	......	......
0	....	20	Cu.	0	....	n e	..	n	..	...	..	....	....	......	......
0	....	40	Cu.	0	....	s w	..	s w	..	...	..	....	....	......	......
15	Ci.	30	Ci. Cu.	35	St.	s	..	s w	..	s w	..	....	....	......	......
0	....	100	Cu. St.	0	....	s w	..	w	..	s	..	....	....	......	......
0	....	65	Cu.	0	....	w	..	w	..	w	..	....	....	......	......
40	Cu.	45	Cu.	5	St.	w	..	w	..	w	..	....	....	......	......
0	....	0	....	0	....	n w	..	n	..	n	..	....	....	......	......
0	....	20	Ci.	80	Cu. St.	s e	..	s	..	s	..	....	....	......	......
100	St.	100	St.	0	....	s w	..	w	..	...	..	Night	*	.40	......
0	....	0	....	0	....	n w	..	n e	..	e	..	....	....	......	......
5	Ci.	60	Ci.	0	....	e	..	s	..	s	..	....	....	......	......
100	St.	70	Cu. St.	.....	....	s w	..	w	..	...	..	....	....	......	......
.....	....	.....	....	.....	....	...	..	...	..	...	..	....	....	......	......
50	St.	50	St.	100	St.	s w	..	s w	..	w	..	....	....	......	......
.....	....	.....	....	.....	....	n w	..	...	..	...	..	....	Night	trace	......
.....	....	.....	....	.....	....	...	..	...	..	...	..	....	....	......	......
100	St.	.....	....	.....	....	s w	..	...	..	...	..	Day	Night	2.4	......
100	Cu. St.	.....	....	.....	....	n w	..	...	..	...	..	....	....	......	......
50	Cu.	.....	....	100	Cu.Nim	s w	..	...	..	w	..	Night	....	.46	......
100	St.	5	Cu.	0	....	n w	..	n	..	...	..	....	....	......	......
0	....	0	....	5	Ci.	e	..	e	..	s	..	....	....	......	......
5	Ci.	0	....	0	....	s	..	s w	..	...	..	....	....	......	......
100	St.	15	Ci.	0	....	w	..	w	..	w	..	....	....	......	......
0	....	35	Cu.	0	....	s w	..	w	..	s w	..	....	....	......	......
0	....	15	Ci.	20	Ci.	s	..	s	..	s	..	....	....	......	......
0	....	35	Ci.	0	....	s	..	s	..	s	..	....	....	......	......
100	St.	100	St.	100	St.	n	..	n	..	n	..	....	....	......	......
70	St.	20	Ci.	15	St.	e	..	e	..	e	..	....	....	......	......
100	St.	60	St.	100	St.	w	..	w	..	w	..	....	....	......	......
1045	....	925	....	640	....	...	..	...	..	...	..	....	....	3.26	......
39	....	39	....	27	....	...	..	...	..	...	..	....	....	......	......
		35				...	..	...	..	...	..	....	....	......	......

*10:30 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	70	79	64	100	100	89	28.987	28.932	28.908	80	62
2.......	76	80	66	95	91	89	28.830	28.867	28.910	82	63
3.......	64	.....	.....	89	.....	.....	28.928	....	....	......	58
4.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
5.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
6.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
7.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
8.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
9.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
10.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
11.......	.....	.....	.....	.....	.....	.....	....	....	....	......	......
12.......	.....	.....	.....	.....	.....	.....	....	....	....	84	......
13.......	63	.....	.....	83	.....	.....	....	....	....	69	42
14.......	51	.....	.....	100	.....	.....	....	....	....	......	50
15.......	.....	.....	.....	.....	.....	.....	....	....	....	66	......
16.......	60	74	57	77	.....	.....	....	....	....	74	49
17.......	55	80	73	81	78	90	29.013	28.845	28.827	82	45
18.......	.....	.....	.....	.....	.....	.....	28.887	....	....	73	53
19.......	61	75	68	94	86	90	29.033	28.997	28.980	75	54
20.......	55	58	45	87	94	100	29.061	29.092	29.264	59	54
21.......	39	53	40	91	80	100	29.438	29.421	29.459	55	32
22.......	45	57	45	84	75	100	29.530	29.395	29.351	58	32
23.......	49	71	68	85	80	90	29.110	29.070	29.002	71	42
24.......	67	72	63	95	90	100	28.845	28.787	28.858	73	63
25.......	56	64	60	100	94	94	29.036	28.973	28.848	69	55
26.......	58	62	58	100	100	94	28.813	28.845	28.875	64	55
27.......	57	70	62	94	95	94	28.971	28.938	28.980	72	54
28.......	62	65	67	88	94	95	29.035	28.992	28.925	69	58
29.......	73	75	64	95	81	89	28.827	28.852	28.852	78	64
30.......	57	64	53	81	73	87	28.991	28.933	28.905	66	56
Sums....	940	1099	953	1719	1311	1401	435.520	434.939	434.944	1269	933
Means...	.....	.....	.....	90	87	93	....	....	....	70.50	51.83
Average..	.....	.....	.....		90		....	....	....	......	18.67

SEPTEMBER, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	100	St.	90	St.	n w		w		s w					
95	St.	100	St.	0		s w		s		s w		Day	Day	.03	
20	Ci.					s w									
												Day	Night	.45	
						s w									
				100	St.	e				s e					
100	St.					n w						Night	Night	.08	
				20	St.	s w		s w		s w					
				50	St.	e		s w				Night		.41	
						s w									
100						s e		s e		s e					
100				0		n				n					
0		5	Ci. Cu.	5	Ci.	n		n e		e					
0		0		0		n e		s e		s					
40	Ci.	60	Ci.	100	Cu. St.	s e		s w		s w					
100	St.	100	St.	100	St.	w		s w		w		5 a. m.	10 a. m.	.41	
100	St.	100	St.	100	St.	n w		n w		n w		9 p. m.	Night	.67	
100	St.	100	St.	90	St. Cu.	w		n w		n w					
80	St. Cu.	40	Ci. Cu.	10	Ci. Cu.	n w		e		e					
80	Ci. St.	100	St.	60	Ci. St.	s e		s e		s		12 m.	1:30 p.m.	.28	
90	Cu. St.	85	Ci. Cu.	0		w		w		w		Night		.02	
25	Ci.	20	Ci.	20	Ci.	n w		n w		w					
1130		810		745										2.35	
71		68		47											
		62													

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	52	61	56	86	77	100	28.866	28.752	28.725	64	47
2.......	50	56	43	100	75	100	28.668	28.688	28.818	58	49
3.......	39	53	42	91	80	91	29.029	29.028	29.086	55	32
4.......	46	51	54	92	86	93	29.106	28.978	28.935	54	41
5.......	56	55	47	100	87	92	28.863	28.963	29.202	57	52
6.......	35	47	35	80	77	93	29.393	29.396	29.394	49	30
7.......	35	52	45	90	73	92	29.382	29.206	29.061	53	30
8.......	52	63	60	93	94	100	29.023	28.995	29.008	64	44
9.......	61	67	72	100	100	90	29.053	28.940	28.808	73	56
10.......	69	77	61	95	82	100	28.685	28.622	28.700	77	65
11.......	53	56	51	93	87	93	28.863	28.968	29.011	56	51
12.......	46	53	40	100	80	100	29.180	29.238	29.284	54	40
13.......	41	55	42	100	87	100	29.335	29.333	29.336	58	38
14.......	39	52	46	91	86	100	29.406	29.356	29.352	55	33
15.......	42	57	44	91	75	92	29.322	29.224	29.212	61	38
16.......	52	65	51	79	78	86	29.175	29.110	29.091	67	36
17.......	51	72	61	86	76	77	29.063	29.005	29.005	75	45
18.......	55	76	58	87	77	82	29.063	29.007	28.988	78	51
19.......	52	74	61	86	76	77	28.953	28.812	28.718	75	49
20.......	52	49	45	86	93	92	28.980	28.564	28.527	54	45
21.......	41	47	42	91	92	100	28.418	28.294	28.362	49	39
22.......	41	45	37	91	68	90	28.575	28.689	28.873	47	37
23.......	39	46	35	73	84	90	29.028	29.038	29.039	47	31
24.......	43	56	47	67	94	92	28.878	28.784	28.915	57	33
25.......	42	46	40	100	77	91	29.095	29.087	29.098	48	41
26.......	36	36	32	100	100	100	29.095	29.102	29.185	39	32
27.......	33	43	35	100	75	90	29.279	29.183	29.146	44	29
28.......	34	51	42	90	79	91	29.081	29.012	29.025	57	32
29.......	43	60	40	83	77	91	29.068	29.222	29.271	62	35
30.......	39	.....	35	82	......	......	29.355	....	....	48	29
31.......	36	58	30	61	100	......	....	....	....	......	22
Sums....	1366	1679	1394	2764	2492	2685	841.925	840.596	841.175	1729	1210
Means...	.....	.....	.....	89	83	93	....	....	....	57.63	40.33
Average..	.....	.....	.....		88		....	....	....	......	17.30

OCTOBER, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
0		100	St.	100	St.	n w		n w		n w					
100	St.	40	Ci. Cu.	0		n w		w		n					
0		30	Cu. St.	0		w		w							
100	St.	100	St.	100	St.	s e		s e				9:30 a.m.	8 p.m.	.76	
100	St.	100	St.	0		s w		w		n					
0		100	St.	0		n		n		n					
0		30	Ci. St.	95	St.	e		s		s					
100	St.	100	St.	90	St.	s w		s w		s w		Night	Night	.15	
100	St.	100	St.	95	St.	s		s		s w		12:30	11:30.	.10	
100	St.	65	St. Cu.	90	St.	s w		s w		s w		3 p. m.	6 p. m.	.72	
95	St.	100	St.	100	St.	n w		n		n					
100	St.	80	St. Cu.	0		n		n		n					
50	Ci. St	0		0		n e		n e		n e					
15	Ci.	100	St.	0		n w		n e		n e					
100	St.	20	Ci.	0		s e		s		s					
10	Ci.	15	Ci.	0		s		s		s					
10	Ci.	10	Ci.	0		s		s w		s w					
0		0		10	Ci.	w		s w		s w					
15	Ci.	30	Ci.	75	Ci. St.	s		s e		s e					
5	St. Cu.	100	St.	95	St.	s w		s		s w					
100	St.	100	St.	100	St.	s w		s w		s w		Night	Night	.17	
20	Ci. St.	90	Cu. St	60	Ci. Cu.	s w		w		n w					
10	Cu. St.	0		5	Ci.	w		w		s e					
100	St.	90	Ci. St.	10	Ci.	s		s w		w					
100	Cu. St.	60	St. Cu.	100	St.	w		w		w		Night	Night		1.8
60	Cu. St.	100	St.	0		s w		n w		n w					
100	St.	15	Cu.	60	Cu. St.	n w		n w		s w					
95	Cu. St.	10	Cu. St.	0		s w		s w		s w					
0		3	Cu.	30	Cu.	s w		s w		n					
0						n e		s e		s w					
0		0				s		s w		s w					
1585		1688		1215											
51		56		42											
		50													

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering Thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	.....	66	48	......	79	100	29.154	29.143	29.162	68	34
2.......	45	65	49	100	89	100	29.190	29.112	29.095	66	42
3.......	43	67	50	83	95	100	29.118	29.014	29.005	69	40
4.......	40	66	39	100	100	100	28.933	28.853	28.881	66	36
5.......	39	46	38	100	77	100	28.893	28.878	28.933	52	34
6.......	34	44	33	90	92	100	28.984	28.934	28.936	45	25
7.......	34	39	29	90	82	100	28.936	28.930	28.918	39	29
8.......	28	43	32	100	100	100	28.903	28.880	28.905	43	25
9.......	30	43	35	100	100	90	28.860	28.847	28.960	44	27
10.......	33	40	32	89	82	100	29.141	29.178	29.212	42	32
11.......	24	44	31	87	84	100	29.232	29.168	29.086	46	21
12.......	34	45	37	90	100	90	28.895	28.652	28.610	47	28
13.......	31	39	35	100	100	90	28.563	28.623	28.801	39	29
14.......	34	39	31	100	91	100	29.023	29.027	29.068	40	30
15.......	32	50	36	100	86	100	29.079	29.007	29.086	51	29
16.......	32	56	36	100	81	90	29.254	29.227	29.322	57	27
17.......	37	54	47	90	74	85	29.272	29.124	29.083	54	32
18.......	39	61	49	91	77	93	29.083	29.020	29.028	62	38
19.......	44	66	49	92	79	78	29.026	28.935	28.808	68	43
20.......	52	54	46	86	87	92	28.673	28.565	28.630	57	46
21.......	29	46	38	100	77	91	29.089	29.050	28.943	47	27
22.......	39	50	36	100	79	100	28.871	28.847	28.938	52	36
23.......	38	.....	.....	72	......	......	28.730	....	....	48	31
24.......	.....	.....	.....	......	......	......	....	....	....	......	......
25.......	.....	.....	.....	......	......	......	....	....	....	......	......
26.......	.....	.....	.....	......	......	......	....	....	....	......	......
27.......	20	.....	.....	100	......	......	....	....	....	26	18
28.......	18	23	34	100	60	61	29.115	29.010	28.535	34	15
29.......	37	35	29	100	80	100	28.470	28.539	28.713	41	29
30.......	27	27	24	100	100	100	28.822	28.845	28.842	29	24
Sums....	835	1142	895	2460	2151	2360	724.579	723.408	723.500	1332	827
Means...	.....	.....	.....	95	86	94	....	....	....	49.33	30.63
Average..	.....	.....	.....		92		....	....	....	......	18.70

NOVEMBER, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
...	...	0	...	0	...	w	..	w	..	w	..	...	...	...	...
30	St.	0	...	0	...	s w	..	s w	..	s w	..	...	...	...	...
0	...	0	...	0	...	s w	..	s w	..	s w	..	...	...	...	...
30	St.	0	...	0	...	s w	..	n	..	n	..	...	...	...	...
40	St.	100	St.	0	...	n w	..	n w	..	n w	..	...	...	...	...
0	...	0	...	0	...	n w	..	n w	..	n w	..	...	...	...	...
100	St.	100	St.	100	St.	s e	..	s w	..	n w	..	...	...	...	...
...	...	...	...	...	...	n e	..	n e	..	n e	..	...	...	...	...
20	Cu.	...	...	0	...	n e	..	n e	..	n e	..	...	...	...	...
100	St.	80	St.	100	St.	n e	..	n e	..	n	..	...	...	...	...
10	St.	0	...	0	...	s w	..	s w	..	s w	..	...	...	...	...
6	...	10	Ci.	0	...	s w	..	s w	..	s w	..	...	...	...	...
35	Ci. Cu.	10	Cu.	100	St.	n	..	n	..	n	..	...	...	...	...
100	St.	10	Ci.	0	...	n w	..	w	..	s w	..	...	...	...	...
15	Ci.	80	Ci. St.	0	...	s w	..	s w	..	s w	..	...	...	...	...
0	...	0	...	0	...	n e	..	n e	..	e	..	...	...	...	...
90	Ci. St.	75	Ci. St.	95	Ci. Cu.	s e	..	s	..	s	..	...	...	...	...
20	St.	0	...	0	...	s w	..	s w	..	s w	..	...	...	...	...
25	Ci.	25	Ci. Cu.	90	Cu.	s e	..	s w	..	s	..	...	...	...	...
50	Ci. Cu.	100	St.	40	St. Cu.	s	..	s w	..	n w	..	...	...	...	...
0	...	25	Ci.	20	Ci.	s e	..	s	..	s w	..	...	...	...	...
0	...	15	Ci.	35	Ci.	w	..	w	..	w	..	...	...	...	...
70	St.	...	...	...	...	s	..	...	..	...	..	...	...	...	...
...	...	...	...	...	...	...	..	...	..	...	..	...	...	...	...
...	...	...	...	...	...	...	..	...	..	...	..	...	...	...	...
...	...	...	...	...	...	...	..	...	..	...	..	*	12 m.	...	.25
80	Cu.	...	...	...	...	n w	..	...	..	...	..	...	...	...	...
60	St. Ci.	100	St.	100	St.	s e	..	s e	..	s e	..	...	...	...	...
100	St.	100	St.	100	St.	s w	..	s w	..	w	..	...	...	...	...
100	St.	80	St. Cu.	100	St.	w	..	s w	..	w	..	Night	...	...	.25
1075	...	910	...	880	...	...	..	...	..	...	..	...	...	...	...
40	...	36	...	35	...	...	..	...	..	...	..	...	...	...	...
		37				...	..	...	..	...	..	...	...	...	...

*Snow 10 a. m.

METEOROLOGICAL OBSERVATIONS FOR THE MONTH OF

Day of month.	Thermometer, in open air.			Relative humidity or per cent of saturation.			Barometer reduced to freezing point.			Registering thermometer.	
	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	7 A. M.	2 P. M.	9 P. M.	Maximum.	Minimum.
1.......	25	30	22	100	100	100	28.845	28.900	29.083	32	18
2.......	20	23	21	100	100	100	29.176	29.201	29.248	23	19
3.......	18	24	23	100	100	100	29.278	29.275	29.275	25	17
4.......	19	25	13	100	100	100	29.271	29.208	29.182	26	17
5.......	22	28	18	100	100	100	29.050	29.015	29.136	30	11
6.......	15	32	32	100	100	100	29.068	28.760	28.722	33	9
7.......	31	32	30	100	100	100	28.808	28.677	28.555	33	26
8.......	28	27	21	100	100	100	28.640	28.777	28.846	29	21
9.......	12	22	13	100	100	100	28.996	28.947	28.935	23	9
10.......	16	23	20	100	100	100	28.972	29.009	29.060	26	12
11.......	19	23	21	100	100	100	28.997	28.945	28.842	23	15
12.......	21	26	13	100	100	100	28.760	28.777	28.964	26	13
13.......	−2	15	−2	100	100	100	29.211	29.250	29.306	17	−3
14.......	−9	45	12	100	100	100	29.341	29.278	29.204	47	−18
15.......	14	23	18	100	100	100	29.177	29.125	29.058	24	12
16.......	−5	20	13	100	100	100	29.070	29.037	29.000	21	−7
17.......	11	24	9	100	100	100	28.942	28.872	28.845	24	6
18.......	20	28	26	100	100	100	28.789	28.664	28.652	31	4
19.......	29	26	20	100	100	100	28.742	28.863	28.889	29	25
20.......	27	24	22	100	100	100	28.452	28.647	28.920	30	14
21.......	19	26	23	100	100	100	29.193	29.195	29.180	27	16
22.......	29	38	42	100	100	83	29.012	28.892	28.815	42	19
23.......	50	48	28	86	92	100	28.717	28.745	28.910	52	28
24.......	20	23	.....	100	100	......	29.169	....	....	23	17
25.......	.....	.....	.....	.....	......	......	....	....	....	......	15
26.......	.....	.....	.....	.....	......	......	....	....	....	......	22
27.......	32	.....	.....	100	......	......	....	....	....	45	22
28.......	20	.....	.....	100	......	......	....	....	....	21	......
29.......	14	.....	.....	100	......	......	....	....	....	30	10
30.......	28	.....	37	100	......	90	....	....	....	37	13
31.......	38	45	38	91	84	91	28.665	28.672	28.745	45	35
Sums....	467	677	496	2877	2476	2464	695.172	694.731	695.372	853	380
Means...	.....	.....	.....	99	99	99	....	....	....	30.46	13.57
Average..	.....	.....	.....		99		....	....	....	......	16.89

DECEMBER, 1904, AT AGRICULTURAL COLLEGE, LANSING, MICH.

Clouds.						Winds.						Rain and snow.			
7 A. M.		2 P. M.		9 P. M.		7 A. M.		2 P. M.		9 P. M.					
Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Per cent of cloud.	Kind.	Direction.	Force.	Direction.	Force.	Direction.	Force.	Beginning rain or snow.	Ending rain or snow.	Inches of rain or melted snow.	Depth of snow, inches.
100	St.	15	Ci. Cu.	100	St.	n w	..	n w	..	n w	..	Night	Night	......	.25
100	St.	100	St.	100	St.	n e	..	n e	..	n	..	Night	Night	......	1.5
80	St.	100	St.	100	St.	n e	..	n e	..	n e	..	....	....	......	......
60	St.	40	St.	0	....	n e	..	w	..	s	..	....	....	......	......
80	St.	100	St.	0	....	s w	..	s	..	s	..	....	....	......	......
5	St.	5	Ci.	100	St.	s w	..	s w	..	s w	..	....	....	......	......
100	St.	100	St.	15	St.	n w	..	s w	..	s w	..	....	....	......	......
5	St.	100	St.	100	St.	n w	..	n w	..	n w	..	....	....	......	......
0	....	10	Ci.	0	....	n e	..	n e	..	n e	..	....	....	......	......
40	St.	0	....	0	....	n	..	n	..	n	..	....	....	......	......
100	St.	100	St.	100	St.	s w	..	s	..	s	..	*	....	......	......
100	St.	100	St.	0	....	n w	..	n e	..	n	..	....	8 p. m.	......	6.5
5	St.,	0	....	0	....	n w	..	n w	..	s	..	....	....	......	......
.....	....	.....	....	.....	....	s w	..	w	..	n w	..	....	....	......	......
100	St.	100	St.	100	St.	n	..	n e	..	n	..	7 a. m.	12 m.	......	.5
100	St.	80	Ci. St.	100	St.	s e	..	s e	..	n e	..	....	....	......	......
100	St.	40	Ci.	20	Ci.	n e	..	n	..	n e	..	....	....	......	......
100	St.	61	Ci. St.	100	St.	s e	..	s w	..	w	..	....	....	......	......
100	St.	100	St.	80	Ci. St.	n w	..	n	..	w	..	....	....	......	......
100	St.	80	Ci. St.	90	St.	s w	..	w	..	n w	..	....	....	......	......
100	St.	75	St.	100	St.	w	..	s w	..	s w	..	....	....	......	......
90	Cu. Ci.	100	St.	25	Cu. St.	s	..	s w	..	s w	..	....	....	......	......
20	Ci.	100	St.	90	St.	s w	..	n w	..	n w	..	....	....	......	......
100	St.	100	St.	.....	....	n e	..	n e	..	...	..	....	....	......	......
.....	....	.....	....	.....	....	...	..	...	..	...	..	....	....	......	......
.....	....	.....	....	.....	....	...	..	...	..	...	..	....	....	......	......
100	St.	100	St.	100	St.	n e	..	s e	..	s w	..	†	....	.42	......
100	St.	.....	....	.....	....	n w	..	n w	..	n e	..	‡	....	......	1.0
100	St.	.....	....	.....	....	s w	..	n w	..	s e	..	....	....	......	......
.....	....	.....	....	.....	....	w	..	...	..	s w	..	....	....	......	......
50	Ci	15	Ci.	0	....	s w	..	s w	..	s w	..	....	....	......	......
2035	....	1721	....	1420	....	...	..	...	..	...	..	....	....	......	......
70	....	66	....	57	....	...	..	...	..	...	..	....	....	......	......
		64				...	..	...	..	...	..	....	....	......	......

* Snow all day. ‡Rain, cold wave. §Snow in night.

BULLETINS

OF THE

AGRICULTURAL COLLEGE EXPERIMENT STATION

ISSUED DURING THE

YEAR ENDING JUNE 30, 1905.

EXPERIMENT STATION BULLETINS.

FERTILIZER ANALYSES.

BY FLOYD W. ROBISON.

Act No. 26 of the Session Laws of 1885 provides for the inspection and analysis of all brands of commercial fertilizers on sale in Michigan. In order to have these analyses serve the purpose best, it has been considered advisable to publish the results of analyses as early in the summer as the work will permit. These analyses cover goods shipped into the state in the spring of the current year and also in the fall of the previous year. The analyses are made upon goods selected in the open market in all cases when they may be found.

WHAT GOODS ARE SUBJECT TO LICENSE.

This division interprets as subject to license any fertilizer, so-called chemical sold as fertilizer, bone products, salts, ground rock, etc., the retail price of which exceeds $10.00 per ton.

The manufacturer's license extends over a definite period of time and does not cover a definite brand of goods for all time. Because a certain brand of fertilizer is legally on sale during 1903 is no reason why it is legally on sale in 1904. As soon as the time limit of a fertilizer expires, that fertilizer is illegally on sale and is subject to all the provisions of the statute relating to unlawful goods. If dealers have such goods on hand they must either return them to the manufacturer or pay the license fee.

THE OBJECT OF A LICENSE AND ANALYSIS.

It is manifestly impossible by a simple, microscopic examination of a fertilizer to tell anything about its value. Something may be told concerning the purity of food by a physical examination of the food, but the chemist himself can tell little of the value of a fertilizer except he analyze it in his laboratory. It is the recognition of this fact that caused the passage of the fertilizer law and placed it in the control of independent hands. To protect the user of fertilizers in a matter in which he is clearly and wholly incompetent to protect himself was the object of this law. Suppose a farmer decides to buy a fertilizer for his own use, the same fertilizer not being licensed, and as an inducement he is offered it at one or two dollars less per ton. The manufacturer gives him a guaranteed analysis, but he has nothing except the manufacturer's guaranty to assure him that the goods are what they are claimed to be. This station cannot analyse them for him for they are not licensed. He may be using a good fertilizer or he may be using one without value and he has no redress. On the other hand if the fertilizer in question is a licensed one the meaning is clear that the correct analysis of the goods is shown in the Annual Fertilizer Bulletin alongside the manufacturer's guaranty and the farmer knows that he can depend upon it. Neither the station analysis nor the fact that a fertilizer is licensed is proof

that the fertilizer is an especially good one. The object of the analysis is to reveal just what the goods are and just what they contain in fertilizing ingredients and the fact that they are licensed is simply evidence that they have been analyzed and their composition as compared with their claim can be ascertained by consulting the Bulletin. To render this work fully effectual farmers and granges who club together to secure reduced rates should insist before any such goods are bought that they bear the state license. This license requires an open, guaranteed statement of the composition and insures a chemical analysis of the Fertilizer.

LEGAL GOODS.

The fertilizers, the analyses of which are given in this Bulletin, are the only fertilizers that can be sold, lawfully, in this state. They may be sold from May 1, 1904, to May 1, 1905, and if a license is not issued for same on or before the latter date, then the goods must be withdrawn from the market. Dealers, as well as manufacturers, should co-operate with this division in securing evidence of goods unlawfully on sale. Any such evidence will be held in strict confidence and speedily investigated.

REGARDING SAMPLES.

Most of the samples analysed were composite samples obtained by mixing in this laboratory fertilizers obtained from widely different sources. It is considered that the greatest possible fairness is secured by this method. In some instances the same brand has been twice analysed and reported to show the variation to which the goods are subject. This has not been possible on all brands but only on those found in greater quantities.

The following is a partial list of persons and places visited during the past spring. Samples of fertilizers were taken from all or nearly all of these dealers and these samples, gathered in this way from the open market, are the samples the analyses of which appear in this Bulletin. It was formerly a custom to print the name of the dealer opposite the analysis of the sample obtained from him, but so many samples of the same fertilizer are now obtained that such a procedure is no longer feasible.

Adrian—Nathan Smith & Son.
Albion—F. Steele.
Allegan—Schuler & Bourne, B. F. Foster.
Alma—Alma Sugar Co.
Bad Axe—William Rapson & Son, Cosgrove, Freeman & Co., B. A. & Grain Co., A. T. McDonald.
Battle Creek—I. H. Stiles, W. N. Dibble.
Bay City—Jenison Hardware Co., R. C. Bialy, Bay City Hardware Co., Ltd.
Benton Harbor—H. P. Boehn, B. N. Nowlen & Co.
Birmingham—E. R. Smith & Co., J. L. Truax.
Blissfield—M. Wolverton, A. G. Root.
Big Rapids—LaClair & Egglesson.
Capac—Wesley Nye, Colling & Co., Lang Bros.
Caro—M. H. Vaughan, Kelsey & Co., Caro Sugar Co., T. W. Vantyne
Carsonville—C. J. Walker, A. H. Baird, Hartshorn & Anderson.
Carleton—Geiermann Bros., C. H. Reiser.
Clio—J. Wellman & Son, Fred Houghton.
Charlotte—Webster Cobb Co., Garber & Gibbe.
Coloma—Stratton & Blackman, Peck Bros.
Coral—N. B. Atwood & Co.
Clifford—Clifford Elevator Co.
Decatur—D. Trowbridge.
Denton—J. B. Schlicht.
Detroit—S. Baldwin.
Dowagiac—F. J. Reshore.
Durand—Hamlin Bros.
Eaton Rapids—C. D. Weisner.
Farmington—C. B. Pettibone.

Flint—Dane & Vermilya.
Grand Haven—James Locke, George Hancock & Sons.
Grand Rapids—Jones Seed Co., Brown Seed Co., Perkins, Hess & Thompson.
Greenville—M. Ludlow, Callahan & Ames.
Grosvenor—W. J. Rogers.
Hartford—E. D. Goodwin.
Hastings—R. K. Grant.
Holland—Keplar & Son.
Holly—McLaughlin Bros. Co., T. P. Morgan, M. N. Hudson.
Howard City—W. F. Nagle.
Hudson—Mr. Reed.
Ida—Silas Crane, Weiper & Cousino.
Imlay City—J. W. Green.
Ionia—Hubbell & Son.
Jackson—J. E. Bartlett Co., S. M. Isbell & Co.
Lansing—C. D. Woodbury, H. P. Gladden.
Lapeer—Robert King, Chase & Mitchell, Lapeer Mercantile Co., J. A. Porter, E. C. Roberts.
Ludington—Mr. Rasmussen.
Marlette—Kerby & Spring, W. L. Mathews, W. H. Wilson, Nelson Nichas.
Marshall—Hubbard & Beckwith.
Maybee—Leidle & Gramlich.
Milan—W. H. Hack, W. P. Lampkin.
Monroe—Gheckly & Martin.
Mt. Pleasant—Kennedy Bros.
Niles—S. E. Bolton, J. S. Tuttle.
Owosso—J. Brooks & Son, Parque & Graham.
Palmyra—J. E. Rouget, John Miller.
Petersburg—E. W. Spencer, C. J. Cilley.
Pigeon—Charles Schultz.
Pontiac—E. Holland & Sons.
Port Huron—M. D. Baldwin.
Royal Oak—Jacob Erb, J. M. Lawson.
Saginaw—Saginaw Beef Co., J. C. Derby.
Sebewaing—I. C. Liken & Co.
St. Clair—W. R. Kemps.
St. Johns—Byron Hanley, L. G. McKnight & Co.
St. Joseph—G. K. Pixley, E. Burton.
Temperance—A. H. King & Co., Sol Onsted.
Three Rivers—J. E. Griffiths Hardware Co.
Ubly—Thomas Richardson, D. H. Pierce, Sparling, Pierce Elevator Co.
Vassar—F. Miller, L. M. Gage.
West Bay City—Mohr Hardware Co., George L. Mosher.
Wyandotte—Wyman Coal & Ice Co.
Ypsilanti—C. E. Thompson & Son.
Zeeland—Henry DeKriuf, Isaac Vandyke & Co.

BARNYARD MANURE AND COMMERCIAL FERTILIZERS.

There are few subjects which it seems can with propriety be discussed more frequently than the relative importance of barnyard manure and commercial fertilizers. There is abundant evidence to show that commercial fertilizers can never, on the American farm, entirely supersede the use of barnyard manure. Pound for pound most fertilizers contain very much more nitrogen, phosphoric acid and potash than does barnyard manure, but in most instances the growing test is in favor of the manure. There is unquestionably an influence physical, chemical or bacterial or all together that has a favorable effect on plant life and which can not be attributed solely to the nitrogen, phosphoric acid and potash present. Where all the products of the farm are fed on the premises and cared for properly there should be sufficient manure to keep the farm in a high state of fertility and on such a farm, in our opinion, the use of commercial fertilizers would be uneconom-

ical. However, on small truck farms and on others where but little barnyard manure is available the use of commercial fertilizers is commendable. It is reasonable to suppose that no system of farming can be permanent that continually robs the soil of nutritive material without returning something to it. There is no question but that barnyard manure is the best source at the disposal of the farmer, to permanently increase the productivity of his land. No other fertilizer is so lasting in its effects. The great difficulty with a large number of Michigan farms is that it is impossible to obtain enough of this manure. On such farms commercial fertilizers have been used with a great deal of success and as the system of farming becomes more intensive the use of commercial fertilizers must likewise increase. All farmers cannot be dairymen and stockmen. Some must sell the wheat, fruits and garden products to support the rapidly increasing city populations, and such farmers must replenish in commercial fertilizers the equivalent, at least, of that which the exported crop removed. *The use of commercial fertilizers is not a fad and it will not down.* The man who has plenty of barnyard manure, however, will not buy fertilizers extensively, for they are clearly in a class below the natural manures, but the farmer who has not barnyard manure and cannot get it is compelled to use commercial fertilizers if he would keep pace with his neighbor in the productiveness of his land. On a still too large number of Michigan farms the great value of farm manures is not appreciated, neither is there exhibited great familiarity with the constituents and properties of these natural manures. The farmer who would use manures to the best advantage must become a student of the conditions causing the production of manures and the sources from which they are obtained. Comparatively few indeed are the farms where special effort is made to preserve the liquid manure from the stock fed and yet that is the most valuable portion of the animal excrement. The author is thoroughly familiar with countless examples of stables wherein the liquid excrement of animals instead of being saved in the manure, seeps through the cracks and holes in the floor and soaks into the ground beneath the barn, where, instead of being of value to the farmer, it becomes a constant menace to the health of the animals and the inhabitants of the near-by dwelling. Some way of saving this material as well as the solid manure should be found and then in most cases let the manure be applied as fresh as possible to the land. It is quite generally conceded by practical men and scientists as well that the maximum effect is produced by the application of manures as soon as made. This is not always possible and yet it is usually found that the difficulty is apparent rather than real.

It does not seem to be a great task for some farmers to get into the habit of removing a wagon load of manure to the field as soon as it is ready and a habit of this nature, once formed, is productive of untold benefit. Let no farmer neglect the natural farm manures for the more easily handled commercial fertilizers but rather let the user of commercial fertilizers secure and use therewith as much barnyard manure as he can obtain.

LEGUMES, COTTON SEED MEAL, ETC.

It is quite generally conceded that a first rate method of reviving some lands is to plow under a crop of clover or some other legume as a green manure It has been considered one of the best ways of applying a nitrogenous fertilizer to the soil, and it has the advantage over commercial fertilizers that ordinary barnyard manure has in that it is quite lasting in its effects. The benefit due to a leguminous crop is far beyond the actual composition of the plant for the effect of the decomposition is to materially change the climate and physical condition of the soil. On a farm well provided with barnyard manure, due to the feeding of much stock, it is doubtful if the benefits derived from the turning under of a leguminous crop are sufficient to counterbalance the value of the crop for feeding purposes. The application of the manure in large quantities would undoubtedly serve as well or at least nearly as well as the green manure, and at the same time the crop of clover will have contributed to the food of the stock. On farms or in orchards where no stock are kept and where the supply of barnyard manure is very limited the green manuring with a leguminous crop will be found a valuable contribution to the fertility of the soil.

In the southern states cotton seed meal is much used as a nitrogenous fertilizer, being applied directly to the land. It serves the purpose admirably and has an influence similar to that of barnyard manure and clover. Its great value for feeding purposes will prevent the use of this material on stock and dairy farms in Michigan for in this case as with clover, its value after feeding will be nearly as great as before and the intermediate product— milk or beef—will be an added source of wealth.

On small farms, gardens and orchards where no barnyard manure is available, cotton seed meal should prove a valuable manure. It contains a much higher content of nitrogen than do most commercial fertilizers and besides contributes much to the humus supply of the soil.

WOOD ASHES.

Much has been said regarding the value of unleached wood ashes—too much it would seem in some instances, for in many cases wood ashes have been used with quite detrimental effects. On some soils, not already light and sandy, wood ashes are valuable, for, besides supplying about 5% of water-soluble potash, the lime present in the ashes aids materially in producing a better physical condition of the soil. However, it is doubtful if in most cases ashes can be considered to have any commercial value above that of the potash they contain. In general it may be said that wherever lime is desirable on a soil there ashes will also be beneficial.

CONCERNING FERTILIZER BUYING.

Fertilizers should be bought according to the needs of the soil and crop and not because they are cheap. A farm that is well nourished with barnyard manure would not return the value of even the cheapest fertilizers. On the other hand on a farm which is in a run-down condition the dearest fertilizer available may be the cheapest in the end. Fertilizers are usually bought on the ton basis and yet that means little regarding their actual values. The bulletin gives the results of the analysis expressed in parts in a hundred. To get the parts in a ton it is only necessary to multiply these figures by 20 and the actual amounts of nitrogen, phosphoric acid and potash expressed in pounds in a ton will then be found. That a ton of one fertilizer can be bought for $20.00 is by no means a reason that it is cheaper than another that sells for $30.00. It is the analysis that tells and it is more frequently true that the fertilizer selling for the higher price is really the cheaper because it contains a correspondingly larger amount of the desired ingredients.

THE USE OF FILLER IN FERTILIZERS.

It is assuredly true that high grade goods containing little or no filler are much cheaper than low grade goods. A filler is used by the manufacturer to supply the farmers' demand for a cheap fertilizer. The filler may be dirt or any other substance not injurious to the soil. It costs the manufacturer a considerable amount to import the filler, mix it with the raw goods and transport it again to the farmer and it is of course the user who eventually stands all this expense. If the farmer will use high grade fertilizers or even the pure chemicals and salts themselves he will obtain his nitrogen, phosphoric acid and potash at a considerably reduced figure. By so doing he will not be paying the manufacturer for mixing and transporting a useless material as a filler and he will also save himself much labor in distributing the fertilizer on his land.

VALUATION OF FERTILIZERS.

The following prices may be used as representing quite closely the retail cost per pound of the ordinary forms of nitrogen, phosphoric acid and potash in chemicals and raw materials in our large markets. This cost does not include mixing nor transportation.

Nitrogen in nitrates	costs about	15c per lb.
Nitrogen in ammonia salts	" "	17½c per lb.
Nitrogen in organic matter	" "	17c per lb.
*Phosphoric acid (available)	" "	4c per lb.
Phosphoric acid insoluble	" "	2½c per lb.
Potash in the form of muriate	" "	4½c per lb.
Potash in the form of sulphate	" "	5c per lb.
Potash in the form of carbonate (ashes)	" "	5c per lb.

HOW TO CALCULATE VALUES.

The value of a commercial fertilizer depends entirely on the values of the nitrogen, phosphoric acid and potash present. The following is an example:—

	Analysis. Per cent.	Valuation.	Total value.
Nitrogen	=7.77×20×	.17=	$16.22
Available phosphoric acid	=2.40×20×	0.04=	1.92
Insoluble phosphoric acid	=2.10×20×	.025=	1.05
Potash	=1.00×20×	.05=	1.00
Total commercial value			=$20.19

As may be seen above all that is necessary to obtain the commercial value is to multiply the amounts shown in the bulletin by 20 and then by the price per pound of that ingredient as recorded in the table of values.

ACKNOWLEDGMENT.

The analytical data recorded in this Bulletin have been much accelerated by the efficient assistance of Miss Dorothea Moxness, the assistant in chemistry. Mr. E. A. Boyer assisted also in the work of inspection and analysis.

*Note—According to the present methods for the estimation of available phosphoric acid, considerable not strictly available is included. This is due to present imperfections of the methods for estimating phosphoric acid. For example, in bone meals and phosphate slags varying amounts of phosphoric acid go into solution in the citrate reagent according to the temperature and degree of agitation of solution and also according to the degree of fineness of the fertilizer. These varying percentages appear in the analytical tables as available phosphoric acid. It is easily seen that a finely ground bone meal must furnish more real available phosporic acid that one coarsely ground. It fact, it might be considered that with a bone meal ground to a flour nearly all of its phosphoric acid would be available. The Association of Official Agricultural Chemists through its referee on phosphoric acid, is investigating this matter and it is expected that a method will soon be formulated doing away with this imperfection. It seems probable that the value of these goods must be estimated on the total amount of phosphoric acid together with the degree of fineness.

Results of analyses of commercial fertilizers for 1904, expressed in parts of a hundred.

Laboratory number. A	Manufacturer.	Trade Name.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
471	The Armour Fertilizer Works, Chicago.	Phosphate and Potash	Claimed	....	10	2	12	2
			Found	....	9.56	1.27	10.83	1.41
472	The Armour Fertilizer Works, Chicago.	Grain Grower	Claimed	1.65	8	2	10	2
			Found	1.68	8.50	2.64	11.14	2.26
473	The Armour Fertilizer Works, Chicago.	Bean Grower	Claimed	.82	8	2	10	2
			Found	1.67	8.92	.94	9.86	2.45
474	The Armour Fertilizer Works, Chicago.	All Soluble	Claimed	2.88	8	2	10	4
			Found	2.68	8.30	3.25	11.55	4.99
482	The Armour Fertilizer Works, Chicago.	All Soluble	Claimed	2.88	8	2	10	4
			Found	2.72	11.66	1.75	13.41	4.26
481	The Armour Fertilizer Works, Chicago.	Bone, Blood and Potash	Claimed	4.11	8	2	10	7
			Found	4.74	9.31	1.85	11.16	6.69
520	The Armour Fertilizer Works, Chicago	Bone, Blood and Potash	Claimed	4.11	8	2	10	7
			Found	3.82	11.25	2.75	14	5.81
512	The Armour Fertilizer Works, Chicago.	Fruit and Root Crop Special	Claimed	1.65	8	2	10	5
			Found	1.48	9.16	3.15	12.31	3.61
523	The Armour Fertilizer Works, Chicago.	Sugar Beet Special	Claimed	.82	8	2	10	4
			Found	.85	10.17	1.38	11.55	2.36

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
571	The Armour Fertilizer Works, Chicago.	Muriate of Potash	Claimed	....	....	....	....	48
			Found	....	....	....	....	49.14
567	The Armour Fertilizer Works, Chicago.	Steamed Bone Meal	Claimed	1.65	8	12	20	....
			Found	2.51	....	....	22.59	....
581	The Armour Fertilizer Works, Chicago.	Wheat, Corn and Oats Special	Claimed	.82	7	2	9	1
			Found	1.01	9.35	.65	10.58	1.21
583	The Armour Fertilizer Works, Chicago.	Bone Meal	Claimed	2.47	10	14	24	....
			Found	2.47	....	....	23.37	....
588	The Armour Fertilizer Works, Chicago.	Ammoniated Bone with Potash	Claimed	2.47	6	2	8	2
			Found	2.47	7.32	2.05	9.37	2.17
602	The Armour Fertilizer Works, Chicago.	High Grade Potato Fertilizer	Claimed	1.64	8	2	10	10
			Found	1.45	10.90	.72	11.62	12.72
611	The Armour Fertilizer Works, Chicago.	Acidulated Bone Meal	Claimed	1.65	11	7	18	....
			Found	2.65	20.42	2.20	22.62	....
612	The Armour Fertilizer Works, Chicago.	Star Phosphate	Claimed	....	14	2	16	....
			Found	....	16.12	0.50	16.62	....
470	Tuscarora Fertilizer Co., Chicago	Steamed Bone Meal	Claimed	1.65	....	....	20	....
			Found	2.77	....	....	24.95	....

585	Tuscarora Fertilizer Co., Chicago......	Bone Phosphate....................	Claimed.. Found....	....	10 12.70	.... .55	12 13.25	....
594	Tuscarora Fertilizer Co., Chicago......	Michigan Special....................	Claimed.. Found....	1.65 2.15	8 9.82	.... 1.3	10 11.12	5 5.15
601	Tuscarora Fertilizer Co., Chicago......	Tuscarora Standard................	Claimed.. Found....	1.65 1.52	8 10.92	.... .35	10 10.37	2 2.44
603	Tuscarora Fertilizer Co., Chicago......	Ammoniated Phosphate............	Claimed.. Found....	.82 1.	7 9.3	7	9 13	1 1.45
604	Tuscarora Fertilizer Co., Chicago......	Tuscarora Garden..................	Claimed.. Found....	2.88 2.72	8 8.95	.... .55	10 9.50	4 5.78
606	Tuscarora Fertilizer Co., Chicago......	Wolverine Special..................	Claimed.. Found....	.82 1.11	8 11.1	4	10 11.5	4 4.31
607	Tuscarora Fertilizer Co., Chicago......	Acid Phosphate....................	Claimed.. Found....	....	14 10.27	.... .35	16 16.62	....
608	Tuscarora Fertilizer Co., Chicago......	Bone and Potash..................	Claimed.. Found....	....	10 11.85	.... .35	12 13	2 2.12
609	Tuscarora Fertilizer Co., Chicago......	Tuscarora Trucker.................	Claimed.. Found....	4.11 3.85	8 8.37	5	10 8.37	7 11.32
610	Tuscarora Fertilizer Co., Chicago......	Tuscarora Fruit and Potato.........	Claimed.. Found....	1.65 1.78	8 10.77	.... .45	10 11.25	10 11.18
618	Tuscarora Fertilizer Co., Chicago......	Muriate of Potash.................	Claimed.. Found....	....	....	....	....	48 48.
619	Tuscarora Fertilizer Co., Chicago......	Nitrate of Soda....................	Claimed.. Found....	*15.5 15.8	....	....	....	....

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number. A	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
489	Darling & Co., Chicago	Darling's Chicago Brand	Claimed	1.65	8	....	10	2
			Found	1.75	9.80	3.7	13.50	2.79
490	Darling & Co., Chicago	Farmers' Favorite	Claimed	2.47	8	....	10	4
			Found	2.98	8.90	6.2	15.10	5.05
504	Darling & Co., Chicago	Sure Winner	Claimed	.82	8	....	10	3
			Found	.88	9.01	2.55	11.56	3.42
536	Darling & Co., Chicago	Darling's Pure Ground Bone	Claimed	2.47	....	....	23	....
			Found	2.44	....	....	27.12	....
537	Darling & Co., Chicago	Darling's Western Brand	Claimed	.41	7	....	9	.50
			Found	.50	8.40	1.6	10.00	.05
548	Darling & Co., Chicago	Pure Bone and Potash	Claimed	2.14	....	....	20.13	6
			Found	2.15	....	....	21.37	10.15
551	Darling & Co., Chicago	Sure Winner	Claimed	.82	8	....	10	3
			Found	.89	8.87	1.55	10.42	2.78
576	Darling & Co., Chicago	General Crop Brand	Claimed	.82	8	....	10	6
			Found	1.	8.95	1.8	10.75	6.28
590	Darling & Co., Chicago	Acid Phosphate	Claimed	....	10	....	....	....
			Found	....	13.25	1.	14.25	....

475	Swift & Co., Chicago	Bone and Potash	Claimed	2.50	....	....	23.50	3
			Found	1.90	....	....	24.73	4.38
476	Swift & Co., Chicago	Superphosphate	Claimed	1.64	8	....	12	2
			Found	1.53	9.53	3.70	10.32	2.99
484	Swift & Co., Chicago	Superphosphate	Claimed	1.64	8	....	12	2
			Found	1.56	7.04	3.85	11.79	2
477	Swift & Co., Chicago	Complete Fertilizer	Claimed	1	8	....	11	1
			Found	.75	7.70	3.20	10.09	1.18
483	Swift & Co., Chicago	Complete Fertilizer	Claimed	1	8	....	11	1
			Found	.98	8.15	2.35	10.59	1.25
485	Swift & Co., Chicago	Truck Grower	Claimed	.82	8	....	....	4
			Found	.81	8.37	2.1	10.47	3.70
499	Swift & Co., Chicago	Truck Grower	Claimed	.82	8	....	....	4
			Found	.9	8.31	2.75	11.96	4.19
486	Swift & Co., Chicago	Bone Meal	Claimed	2.50	....	....	25	....
			Found	2.20	....	....	20.42	....
488	Swift & Co., Chicago	Bone Meal	Claimed	2.50	....	....	25	....
			Found	2.18	....	....	27.10	....
507	Swift & Co., Chicago	Onion, Potato and Tobacco	Claimed	1.64	8	....	11	7
			Found	1.66	8.42	3.8	12.92	9.32
509	Swift & Co., Chicago	Onion, Potato and Tobacco	Claimed	1.64	8	....	11	7
			Found	2.64	8.25	1.75	19	7.91

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number. A	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
					Available.	Insoluble.	Total.	
508	Swift & Co., Chicago	Swift's Lawn Fertilizer	Claimed	3.75	....	....	23	....
			Found	3.79	....	....	24.90	....
516	Swift & Co., Chicago	Vegetable Grower	Claimed	3.25	9	....	10	10
			Found	2.50	7.31	4	11.31	15.1
534	Swift & Co., Chicago	Sugar Beet Grower	Claimed	2.50	8	....	11	5
			Found	2.69	9.14	1.55	10.69	6.41
579	Swift & Co., Chicago	Special Phosphate and Potash	Claimed	....	10	....	11	2
			Found	....	10.92	.7	11.62	2.06
613	Swift & Co., Chicago	Bone Meal and Blood	Claimed	3.75	....	....	23	....
			Found	2.93	....	....	26.37	....
502	The Jarecki Chemical Co., Sandusky, O.	No. 1 Fish Guano	Claimed	.86	10	....	11	1
			Found	.77	10.61	3.2	13.81	1.20
506	The Jarecki Chemical Co., Sandusky, O.	No. 1 Fish Guano	Claimed	.86	10	....	11	1
			Found	.99	12.58	2.55	15.13	1.60
530	The Jarecki Chemical Co., Sandusky, O.	Special Sugar Beet Grower	Claimed	.86	8	....	9	4
			Found	.65	8.89	1.8	10.69	3.86
533	The Jarecki Chemical Co., Sandusky, O.	Special Sugar Beet Grower	Claimed	.86	8	....	9	4
			Found	.89	8.56	4.7	13.26	3.72

538	The Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano	Claimed	.86	10	....	11	2
			Found	1.92	10.59	3.85	14.44	2.44
547	The Jarecki Chemical Co., Sandusky, O.	Lake Erie Fish Guano	Claimed	.86	10	....	11	2
			Found	.72	9.40	2.1	11.50	2.67
582	The Jarecki Chemical Co., Sandusky, O.	C. O. D. Phosphate	Claimed	....	14	....	15	....
			Found	....	15.25	2.5	17.75	....
591	The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Potato and Tobacco Food	Claimed	.86	8	....	9	4
			Found	1.42	9.32	1.8	11.12	4.78
596	The Jarecki Chemical Co., Sandusky, O.	Square Brand Phosphate and Potash	Claimed	....	10	....	11	2
			Found	....	13.5	1.7	15.2	1.57
620	The Jarecki Chemical Co., Sandusky, O.	Fish and Potash Grain Special	Claimed	1.2	9	....	10	2
			Found	1.49	11.8	1.4	13	2.87
480	Nathan Smith & Son, Adrian	Fertilene	Claimed	15	20	....	20	25
			Found	12.24	27.84	....	27.84	25.0
568	Speidel & Swartz, Grand Haven	Celery Hustler	Claimed	7.75	3.40	....	4.81	2.25
			Found	6.88	5.85	1.4	7.25	1.71
469	James Boland, Jackson	Blackman	Claimed	2.50	10	....	10	3
			Found	2.99	2.75	11	13.75	3.51
468	E. Burton, St. Joseph	Meat and Bone	Claimed	4.77	2.40	....	4.50	....
			Found	4.77	2.40	2.19	4.56	....
561	Grand Rapids Glue Co., Grand Rapids	Grand Rapids Fertilizer	Claimed	3	6	....	12	1
			Found	1.48	8.05	7.55	18.59	.07

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number. A	Manufacturer.	Trade Name.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
615	Kalamazoo Rendering and Fertilizer Co., Kalamazoo.	Kazoo Brand	Claimed	5	1.5	....	8.5	....
			Found	4.18	8.62	4.25	12.87	....
558	Canton Fertilizer and Chemical Co., Canton, O.	Peerless Corn, Wheat and Grass	Claimed	.86	7	....	8	1
			Found	2.16	10.68	1.19	11.87	2.42
493	Canton Fertilizer and Chemical Co., Canton, O.	Peerless Corn, Wheat and Grass	Claimed	.86	7	....	8	1
			Found	.91	8.95	.9	9.85	1.25
535	Chicago Fertilizer Co., Chicago	Wheat and Corn Special	Claimed	.82	7	....	....	1
			Found	.76	7.47	2.95	10.42	.90
543	Chicago Fertilizer Co., Chicago	Potash Special	Claimed	.82	8	....	....	4
			Found	.84	9.74	3.45	13.19	3.34
545	Chicago Fertilizer Co., Chicago	Bone, Blood and Potash	Claimed	1.23	8	....	....	2
			Found	1.30	9.70	2.8	12.50	2.92
577	Chicago Fertilizer Co., Chicago	Potato, Truck and Tobacco Fertilizer	Claimed	*	*	*	*	*
			Found	....	....	....	....	....
521	The American Agricultural Chemical Co., New York.	Bradley's Dissolved Bone with Potash	Claimed	1	8	....	10	2
			Found	1.21	8.45	2.30	10.75	1.92
549	The American Agricultural Chemical Co., New York.	Bradley's Dissolved Bone with Potash	Claimed	1	8	....	10	2
			Found	1.04	9.44	1.15	10.59	1.56

*Unlicensed.

552	The American Agricultural Chemical Co., New York.	Bradley's B. D. Seafowl Guano......	Claimed..	2.06	8	....	10	1.50
			Found....	1.88	8.81	1.2	9.81	1.28
559	The American Agricultural Chemical Co., New York.	Bradley's Niagara Phosphate........	Claimed..	.82	7	....	8	1
			Found....	1.27	7.67	1.7	9.37	1
574	The American Agricultural Chemical Co., New York.	Bradley's Niagara Phosphate........	Claimed..	.82	7	....	8	1
			Found....	.96	8.4	2.1	16.5	.76
560	The American Agricultural Chemical Co., New York.	Bradley's Alkaline Bone and Potash..	Claimed..	....	11	....	12	2
			Found....	....	11.77	2.35	14.12	2.92
564	The American Agricultural Chemical Co., New York.	Bradley's Soluble Dissolved Bone....	Claimed..	....	14	....	15	....
			Found....	....	14	2.5	16.5	....
491	The American Agricultural Chemical Co., New York.	Crocker's Dissolved Bone and Potash..	Claimed..	....	10	....	....	2
			Found....	....	16.88	1.69	12.43	1.74
497	The American Agricultural Chemical Co., New York.	Crocker's New Rival Ammoniated Superphosphate.	Claimed..	1.23	9	....	....	2
			Found....	1.13	9.42	2.05	11.47	1.07
527	The American Agricultural Chemical Co., New York.	Crocker's New Rival Ammoniated Superphosphate.	Claimed..	1.23	9	....	....	2
			Found....	1.24	10.20	1.6	11.88	2.26
544	The American Agricultural Chemical Co., New York.	Crocker's General Crop Phosphate....	Claimed..	.82	7	....	....	1
			Found....	.74	7.82	1.8	9.02	1.16
570	The American Agricultural Chemical Co., New York.	Crocker's Ammoniated Bone Superphosphate.	Claimed..	2.46	9	....	....	2
			Found....	2.36	8.57	1.3	9.87	1.60
597	The American Agricultural Chemical Co., New York.	Crocker's Ammoniated Wheat and Corn Phosphate.	Claimed..	2.05	8	....	....	1.50
			Found....	1.95	9.95	.3	18.75	1.30

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
					Available.	Insoluble.	Total.	
599	The American Agricultural Chemical Co., New York.	Crocker's Universal Grain Grower....	Claimed.. Found....	.82 .93	8 8.52	.... 1.85	.... 10.37	2 1.89
514	The American Agricultural Chemical Co., New York.	Niagara Wheat and Corn Producer...	Claimed.. Found....	1.23 1.40	9 9.72	.... 2.90	.... 12.62	2 1.98
589	The American Agricultural Chemical Co., New York.	Niagara Dissolved Bone and Potash..	Claimed.. Found....	....	10 10.12	.... 3.25	.... 13.37	2 1.78
595	The American Agricultural Chemical Co., New York.	Niagara Potato and Vegetable Fertilizer.	Claimed.. Found....	2.05 1.87	8 8.72	.... 1.15	.... 9.87	3 2.79
592	The American Agricultural Chemical Co., New York.	Niagara Grain and Grass Grower.....	Claimed.. Found....	.82 .88	7 7.97	.... 1.90	.... 9.87	1 1.04
598	The American Agricultural Chemical Co., New York.	Fine Ground Bone..................	Claimed.. Found....	2.47 2.12	....	....	22.8 30.87	....
562	The American Agricultural Chemical Co., New York.	High Grade Garden and Vegetable Fertilizer.	Claimed.. Found....	2 2.19	8 9.05	.... .95	 10	6 8.30
492	Michigan Carbon Works, Detroit......	Homestead, a Bone Black Fertilizer..	Claimed.. Found ...	2.06 2.06	8 9.55	5	.... 10.05	1.50 1.79
517	Michigan Carbon Works, Detroit......	Homestead, a Bone Black Fertilizer..	Claimed.. Found....	2.06 1.96	8 9.10	 1	.... 10.10	1.50 1.68

515	Michigan Carbon Works, Detroit......	Homestead Odorless Bone Black.....	Claimed..	*	*	*	*	*
			Found....					
498	Michigan Carbon Works, Detroit......	Homestead Potato and Tobacco Fertilizer.	Claimed..	2.06	8	....	....	3
			Found....	2.34	8.8	1.6	10.4	2.98
550	Michigan Carbon Works, Detroit......	Homestead Potato and Tobacco Fertilizer.	Claimed..	2.06	8	....	....	3
			Found....	1.99	8.68	.50	9.13	1.39
500	Michigan Carbon Works, Detroit......	Homestead Sugar Beet Fertilizer.....	Claimed..	1.23	9	....	....	2
			Found....	1.50	9.17	2.7	11.87	2.56
511	Michigan Carbon Works, Detroit......	Homestead Sugar Beet Fertilizer.....	Claimed..	1.23	9	....	....	2
			Found....	1.38	8.57	3.05	11.62	1.52
496	Michigan Carbon Works, Detroit......	Red Line Complete Manure.........	Claimed..	.82	7	....	....	1
			Found....	.84	8.99	2.1	11.99	1.58
503	Michigan Carbon Works, Detroit......	Red Line Complete Manure.........	Claimed..	.82	7	....	....	1
			Found....	1.01	8.29	3.4	11.69	1.11
526	Michigan Carbon Works, Detroit......	Red Line Phosphate...............	Claimed..	....	14	....	....	....
			Found....	....	15.99	.85	16.75	....
586	Michigan Carbon Works, Detroit......	Red Line Phosphate with Potash....	Claimed..	....	10	....	....	2
			Found....	....	10.15	3.35	13.59	1.75
513	Michigan Carbon Works, Detroit......	Banner Dissolved Bone.............	Claimed..	....	30	....	....	....
			Found....	....	35.81	....	....	....
528	Michigan Carbon Works, Detroit......	Dessicated Bone..................	Claimed..	†1.23	....	....	25	....
			Found....	1.26	....	....	24.56	....

*Unlicensed.
†Ammonia=1.50.

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number.	Manufacturer.	Trade name.		Nitrogen.	Phosphoric acid. Available.	Phosphoric acid. Insoluble.	Phosphoric acid. Total.	Potash soluble in water, estimated as K_2O.
532	Michigan Carbon Works, Detroit......	Wolverine Phosphate...............	Claimed..	....	10	....	....	....
			Found....	....	8.55	1.45	10	....
644	Michigan Carbon Works, Detroit......	Pure Animal Bone and Potash.......	Claimed..	.82	....	....	22	10
			Found....	.47	....	....	20.12	8.16
529	Michigan Carbon Works, Detroit......	Pure Animal Bone and Potash.......	Claimed..	.82	....	....	22	10
			Found....	.65	....	....	27.87	8.61
505	Northwestern Fertilizing Co., Chicago.	Garden City Superphosphate........	Claimed..	2.05	8	....	10	1.50
			Found....	1.99	8.23	.90	9.13	1.32
519	Northwestern Fertilizing Co., Chicago.	Accidulated Bone and Potash.......	Claimed..	.82	10	....	12	1
			Found....	.35	11.89	1.55	13.44	.71
524	Northwestern Fertilizing Co., Chicago.	Horseshoe Brand Potato Grower.....	Claimed..	2.46	9	....	11	2
			Found....	2.19	7.77	2.85	10.62	1.48
539	Northwestern Fertilizing Co., Chicago.	Horseshoe Brand Sugar Beet Fertilizer.	Claimed..	1.23	9	....	....	2
			Found....	1.24	10.07	2.05	12.12	1.97
546	Northwestern Fertilizing Co., Chicago.	Horseshoe Brand Corn and Wheat Grower.	Claimed..	1.64	8	....	10	2
			Found....	1.43	9.14	1.4	10.54	3.21
569	Northwestern Fertilizing Co., Chicago.	Quick acting Phosphate............	Claimed..	....	10	....	12	....
			Found....	....	11.92	.7	12.62	....

584	The Grange Fertilizer Co., Detroit.....	Michigan Grange Wheat Fertilizer with Potash.	Claimed............ Found.............		10 9.87	.... 3.25	11 13.12	2 1.71
587	The Grange Fertilizer Co., Detroit.....	Michigan Grange Wheat Fertilizer....	Claimed............ Found.............		14 13.50	.... 3.25	15 16.75	....
593	The Grange Fertilizer Co., Detroit.....	Michigan Grange, Corn, Oats and Grass.	Claimed.. Found....	1.65 1.57	8 10.97	.... 1.39	9 11.37	2 2.15
600	The Grange Fertilizer Co., Detroit.....	Michigan Grange Complete Manure...	Claimed.. Found....	.82 .79	7 8.52	.... 1.35	8 9.87	1 1.04
605	The Grange Fertilizer Co., Detroit.....	Michigan Grange Potato and Vegetable Fertilizer.	Claimed.. Found....	.85 .90	8 9.5	 2	.... 11.5	4 3.87
510	The Ohio Farmers' Fertilizer Co., Columbus, O.	Ammoniated Bone and Potash.......	Claimed.. Found....	.82 .91	8 9.15	.... 3.55	.... 12.79	4 4.49
522	The Ohio Farmers' Fertilizer Co., Columbus, O.	General Crop Fish Guano...........	Claimed.. Found....	.82 .62	7 10.65	.... 1.35	.... 12.59	1 1.79
531	The Ohio Farmers' Fertilizer Co., Columbus, O.	Corn, Oats and Wheat Fish Guano...	Claimed.. Found....	1.23 1.49	8 8.41	.... 2.99	.... 11.31	2 2.29
541	The Ohio Farmers' Fertilizer Co., Columbus, O.	Corn, Oats and Wheat Fish Guano...	Claimed.. Found....	1.23 1.93	8 8.80	.... 3.45	.... 12.25	2 1.85
572	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Tobacco Food..............	Claimed.. Found....	.82 .95	8 9.37	.... 1.50	9 10.87	4 4.12
575	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Grain and Grass Grower.....	Claimed.. Found....	.82 .78	10 10.89	.... 2.45	11 13.25	1 1.33

Results of analyses of commercial fertilizers for 1904, expressed in parts in a hundred.

Laboratory number. A	Manufacturer.	Trade mark.		Nitrogen.	Phosphoric acid.			Potash soluble in water, estimated as K_2O.
					Available.	Insoluble.	Total.	
580	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol High Grade Guano..........	Claimed..	*	*	*	*	*
			Found....					
621	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Dissolved Bone and Potash...	Claimed..	....	12	....	13	3.00
			Found....	....	**13.80**	**1.95**	**15.75**	**3.93**
622	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Wheat Grower.............	Claimed..	....	14.00	....	15	....
			Found....	....	**14.5**	**2.00**	**16.5**	....
623	The Cincinnati, O., Phosphate Co., Cincinnati, O.	Capitol Alkaline Bone.............	Claimed..	....	10	....	11	2
			Found....	....	**11**	**3.00**	**14.00**	**2.19**

*Unlicensed.

SOME ESSENTIAL SOIL CHANGES PRODUCED BY MICRO-ORGANISMS.

S. FRED EDWARDS.

Bulletin No. 218.

INTRODUCTION.

The object of this bulletin is to review simply and briefly the present knowledge of soil bacteriology in its relation to agriculture with a view to emphasizing the close relationship between bacteriologic principles and the common operations of tilling the soil.

The problem of rendering his poor soil more productive, and his good soil still better, is one in which every farmer of today is interested. We venture the statement that of all the "run down" or abandoned farms in the United States there is not one which could not be made productive again if proper methods of handling the soil were employed.

The failure of land to yield a crop is not due in most cases to a lack of plant food in the soil. Results of chemical analyses show that in average soils throughout the country there is in the first eight inches, enough nitrogen to last 90 years, enough phosphoric acid to last 500 years, and enough potash to last 1,000 years. Why, then, if the soil contains such stores of plant food, does it fail to support crops? Simply because these elements are locked up in such chemical combinations that the plants are unable to utilize them.

The great problem, then, of modern agriculture, is not entirely the conservation of plant food in the soil, but rather the unlocking of the rich stores already in the soil, and placing them in a condition to be assimilated by plants. This unlocking process is carried on naturally by the soil micro-organisms.

Plants, from the mightest forest tree to the tiniest blade of grass, consist of a complex combination of microscopic cells, each cell containing protoplasm. This protoplasm is continually changing, taking up food which is brought to it in the sap, and casting off its waste products in much the same manner as the protoplasm in the animal body.

Bacteria are also plants, consisting, however, of but a single cell filled with protoplasm, which, like that of the higher plants, is continually active in assimilating from the surrounding medium the food elements necessary for its maintenance. These myriads of little plants, invisible to the naked eye, in taking their food from the chemical compounds of the soil, produce in those compounds just the changes necessary to render them useful to the higher plants in making their growth.

CONDITIONS OF GROWTH.

In order that bacterial activity may go on with undiminished vigor, there are certain conditions of the soil which must be provided, certain requirements of the bacteria which must be complied with, namely: temperature, moisture, reaction, respiration, and food supply.

TEMPERATURE.

Soil bacteria are most active at a temperature of 60° to 80° Fah., although some will grow at temperatures as low as 35° and as high as 98° Fah. Hence the different soil processes induced by bacterial action are carried on most rapidly during the summer months, and cease with the setting in of cold weather, proceeding again with the opening of spring.

MOISTURE.

As it is impossible for animals and higher plants to exist for any length of time without water, so it is impossible for bacteria of any kind to exist and be active without water. In the soil there must be moisture present, or the bacteria fail to grow and carry on their functions, in fact many of them will die; hence the necessity of conservation of the soil moisture by frequent and thorough cultivation, not only for the benefit of the crop, but also for the benefit of the soil bacteria.

REACTION.

A third essential point in furnishing a proper environment for soil bacteria is to have the soil exhibit a proper reaction. Laboratory experience has shown that soil micro-organisms will not develop in an acid medium. It must be about neutral or slightly alkaline to litmus. If too much humus is present in the soil the decomposition of the same may result in the formation of various organic acids which prevent further growth of bacteria. Such soil we say is "sour," and vegetation is scarce because the bacteria are checked and are unable to change the plant food to a form in which it may be assimilated. Such a condition may be remedied by the addition of lime to the soil in amounts of 1,500 to 2,000 pounds per acre. Considerable discretion should be observed, however, in the liming of soils, as actual tests often show that soils seemingly sour are, in reality, not acid, but rather are very perceptibly alkaline. On such lands the addition of lime would only aggravate rather than alleviate the trouble.

RESPIRATION.

One of the first essentials for the vigorous growth of soil bacteria is a bountiful supply of oxygen, as most of them are checked in their growth in proportion as the oxygen supply is reduced. About one-half the volume of average soil under ordinary conditions is "pore space." The soil water is gathered in films round the soil granules, thus leaving air spaces of greater or less size according to the amount of moisture in the soil. This may be represented by a diagram such as is shown in Figure I. The soil granules are represented by the ruled spheres, the water films by the dotted areas surrounding them, and the air spaces by the clear areas, p, p, p, p, connected with each other, forming an intricate and complex system. It is through these openings and channels that the bacteria get the necessary supply of air for their growth. Here is further demonstrated the value of tillage in keeping the soil well aërated as well as to conserve the moisture present.

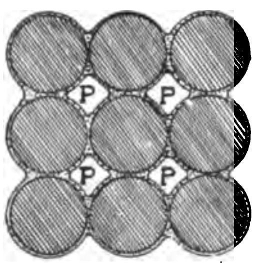


Figure 1.
Diagrammatic illustration of soil particles, surrounded by capillary water films, air spaces, p, p, p, p, after Chester.

FOOD SUPPLY.

Before discussing this requirement, it will be necessary to classify the soil organisms, as each class requires different food materials for its development. They may be broadly divided into four groups: First, the common saprophytic germs acting upon organic matter, which may be designated as the ammonifiers. Second, that group whose especial function is the destruction of nitrates, or the denitrifying organisms. Third, those which build up nitrates or the nitrifiers. Fourth, those whose sole function is to extract free nitrogen from the atmosphere.

AMMONIFICATION.

It will be remembered from the statements of the amount of plant food stored up in the soil, that there is enough nitrogen to last only 90 years. Hence the all important question is that of the nitrogen supply.

When dead organic matter falls upon the ground, it immediately begins to undergo a process of decay. Dead animals left upon the ground or buried in it

are decomposed, and the elements of the animal tissue are incorporated into the soil. Manure placed upon the land rots and enriches it. Dead plants decay and become again a part of the earth from which they sprung. All this decay is brought about by micro-organisms assisted by the elements. The first change that takes place is a breaking down of the complex nitrogenous substances. The albuminous matter is reduced to peptones by certain types of bacteria, and the peptones are reduced to free ammonia and other simple compounds by the same or other types. The starches and sugars meanwhile are undergoing fermentation into various organic acids and gases, as is also the cellulose or woody fiber of plants. Thus the organic matter becomes entirely decomposed, some of the different elements escaping in the form of gases, and others becoming a part of the soil where we shall meet them again later.

The organisms concerned in these different processes may all be placed among the ammonifiers. The life requirements of this group are of importance as touching some of the common soil operations.

A series of laboratory experiments demonstrated the advantage of a bountiful air supply. Flask cultures were made in mineral solutions having potassium nitrate for a basis and containing all the other elements necessary for bacterial growth besides some organic matter in the form of peptone. Four sets of cultures were inoculated with organisms found in different soils on the college farm. One set was placed in an atmosphere from which the oxygen had been completely removed; in the second set the flasks were sealed with wax; in the third they were simply plugged with cotton wool; and in the fourth they were thoroughly aërated After eleven days the cultures were tested for decomposition products. The cultures which had been kept in an atmosphere devoid of oxygen showed only slight traces of ammonia; while the other cultures all showed ammonia in larger quantities, the amount increasing steadily and consistently with the increased amount of oxygen supplied. These results are significant as indicating the effect of the aëration of the compost heap. Manure and litter well packed down so that air is excluded will be much less liable to loss through decomposition and escape of ammonia than that which lies loosely packed, thus affording conditions for such decomposition.

DENITRIFICATION.

There is a process going on in the soil differing from the latter, which results in a direct loss of nitrogen. This is the phenomenon of denitrification, or nitrate destruction. This process is carried on by the denitrifying organisms, which attack the nitrates already formed in the soil, reducing them to nitrites and free ammonia, the fermentation sometimes going still farther to the liberation of free nitrogen. If the soil be abundantly stocked with nitrates, the denitrifying bacteria under favorable conditions would be capable of destroying a considerable portion of them. It is claimed by some workers that as high as 75% of the nitrogen applied to the soil in the form of nitrates is lost by this process. The results of recent investigation, however, tend to prove that this estimate is far too high. Research work upon the oxygen requirements point to the conclusion that the denitrifying organisms develop best when oxygen is excluded. From this conclusion, we obtain another clue to the proper handling of the soil and the compost heap. If the soil is allowed to become packed and hardened through lack of cultivation, the air is excluded and one of the conditions favorable to denitrification is furnished. Again, if the compost heap is packed down the same result follows. But we have seen how probable loss would ensue by leaving the manure loosely compacted. How shall we avoid a loss?

By drawing out the manure as fast as it is made, and spreading it on the land. The loss from leaching is inconsiderable since much of the organic matter composing the manure is insoluble in water; and little decomposition would ensue owing to the dry condition the greater part of the time during the summer and the low temperature at other seasons of the year.

NITRIFICATION.

Opposed to the process of nitrogen waste through denitrification is another process going on simultaneously with it in the soil; a synthetic, rather than an analytic process, whereby simple nitrogen compounds are built up into more

complex bodies. This is the process of nitrification, or nitrate building. In most species of plants the nitrogen necessary for their growth must be in the form of nitrates in order to be dissolved and carried in the sap for ready assimilation by the plant cells. The nitrifying organisms seize upon the ammonia which is formed by the degradation of the complex nitrogenous bodies by the ammonifiers, and by the addition of oxygen to it, they form nitric acid which combines readily with chemical bases in the soil to form nitrates, thus placing the nitrogen at the disposal of the plant.

The nitrifying organisms differ from the preceding classes in their food requirements in that, whereas the denitrifying and ammonifying organisms require at least a trace of organic matter for their best development, the nitrifying organisms do not require organic matter; in fact, they are incapable of growing in the same, although its presence in the soil to a certain extent does not prove fatal to their existence. Hence the advisability of putting too much manure on the land is to be doubted, inasmuch as there would be danger that the reducing bacteria, together with the leaching, would cause the loss of considerable nitrogen before a condition was arrived at under which the nitrifying organisms would be able to thrive.

Another point which is just as essential to the rapid development of the nitrifying organisms as a proper food supply, is that they should be furnished an abundance of oxygen, as they fail to perform their functions in its absence. Here is further shown the necessity for thorough cultivation in order to afford this supply. This fact would also suggest caution against too frequent fallowing of the land. If it is plowed, rolled down, and allowed to lie in that condition, nitrification would be diminished by lack of aëration and the reduction in moisture content. On the other hand, experience has shown that fallowing with frequent and thorough cultivation often gives beneficial results, due possibly to increased nitrification, with the result that, in the absence of a crop, the nitrates thus formed would be conserved.

NITROGEN-GATHERING BACTERIA.

When seeds of plants not belonging to the clover family are placed in soil entirely destitute of nitrogen, but containing all the other chemical elements necessary for plant growth, they will start to grow, but as soon as the food material stored up in the seed itself is exhausted, the plants will wither and die. On the other hand, if seeds of the legumes be placed in the same soil, they will also make a start. Then they begin to wither, and undergo a period of "nitrogen hunger," after which they revive and make a vigorous growth. It is only in comparatively recent years that this phenomenon has been understood. If examination is made of the roots of peas, beans, clovers, alfalfa, and other plants belonging to the same family, there will be found on the roots, small tubercles or nodules. When cut open and examined under the microscope, these are found to contain myriads of bacteria which, by experimental investigation, have been proven to possess the property of extracting free nitrogen from the air. Thus it is that the clovers, themselves so rich in nitrogen, enrich the soil by bringing to it so much more nitrogen than they use up.

This phenomenon of extraction of nitrogen from the atmosphere is often successfully made use of in a practical way in reclaiming fields deficient in nitrogen. Fields that are badly run down through successive cropping, may be again made to yield by inoculating with soil from a field which has recently borne a good crop of some legume, and sowing a leguminous crop. A good stand may often be secured in this way when other methods fail.

Whether organisms from one legume will produce nodules on other legumes and extract nitrogen from the air is still somewhat of an open question. At first it was thought that each species of legume would grow only one species of nitrogen gathering organisms. However, the results of recent research indicate that the nodular organisms from any host may produce nodules on any other host, but that they undergo more or less morphologic change in the transfer.

It is supposed that the nitrogen-gathering organisms utilize the free nitrogen of the air only in proportion to the poverty of the soil in available nitrogen. In other words, the plant does not extract the free nitrogen from the air to any extent unless it is forced to do so. Hence it would be unnecessary to use a fertilizer containing nitrates on a field intended for a leguminous crop.

CHANGES IN POTASH COMPOUNDS.

Potash is quite insoluble in water in the form in which it is usually found in the soil. One of the end products of the decay of humus in the soil is carbon dioxide gas, which, dissolved in the soil water, has a certain amount of solvent action upon the insoluble potash salts producing carbonates, which, in turn, act upon the silicates in the soil, forming an important class of bodies known as potash zeolites (Chester). In this form the potash is less stable and although not strictly soluble in water, it is readily so in dilute organic acids such as result from the decomposition of organic matter.

SULPHUR BACTERIA.

The formation of sulphates in the soil may also be carried on through the agency of micro-organisms. In the dissolution of proteid matter, hydrogen sulphide gas is set free. The sulphur bacteria in the soil and soil water seize upon the hydrogen sulphide, using it as a source of energy, oxidizing the gas and setting the sulphur free. The same bacteria, as well as others, oxidize the free sulphur to sulphuric acid, which unites in the soil to form sulphates. Hence the cycle is complete, the total result of the action being that the sulphur is reduced to soil sulphates in which form it may be utilized by the plant.

IRON BACTERIA.

Iron compounds in the soil are also changed by the activity of micro-organisms, certain bacteria making use of these compounds as sources of energy just as the last group makes use of the sulphur compounds. The iron is found originally in the soil, and is also formed in the destruction of organic matter, the liberated iron combining with carbon dioxide gas present to form carbonates. The carbonates are oxidized by the bacteria, forming iron hydroxide, which is an active chemical agent, and readily unites with phosphorus or silica which may be in the soil, to form phosphates or silicates of iron. These salts are important soil ingredients and contribute to the mineral food of plants.

In discussing the biological changes of the soil we have to consider the relative influence of one process upon another. We may isolate a single species of micro-organism from the soil and study it when growing alone, supplying the same conditions, so far as possible, as are met with in its natural habitat. We find that it produces certain changes. Now, if we isolate another species, and combine it with the first, different products may result. One organism may delay or hasten the growth of another, as is sometimes the case in milk, where it is known that the different kinds of bacteria present exert more or less influence over each other. Further, one organism may precede and pave the way for another, as in vinegar making, where yeasts first change the sugar of the cider to alcohol, making "hard cider," the fermentation being carried on from this point by bacteria which convert the alcohol into acetic acid. So in the soil, the different species undoubtedly are influenced in their products by this associative action, one species, perhaps, by the changes it produces, preparing food for another species or otherwise establishing favorable conditions for its growth; one species in the ascendency at one time, another at another time, the whole result being the maintenance of suitable conditions for the growth and development of plants.

In closing, the author wishes to express his appreciation to Professor Marshall for valuable suggestions, and to Professor Jeffery, of the department of soil physics, who kindly consented to review and criticise the manuscript from the practical standpoint.

SOIL MOISTURE, ITS IMPORTANCE AND MANAGEMENT.

JOS. A. JEFFERY, PROFESSOR OF AGRONOMY AND SOIL PHYSICS.

Bulletin No. 219.

COMPOSITION OF SOILS.

Soils are composed principally of two materials, mineral matter and organic matter.

The mineral matter consists of fragments of rocks, sand and clay. All these have come from the breaking down of larger masses of rock.

The organic matter consists of decomposing leaves, stems and roots of plants, and of the remains of the bodies of animals. When these materials are so far decomposed as to lose their form the resulting organic mass is called *humus*.

In addition to these materials there are found in soils varying quantities of salts of potash, lime, etc., which, dissolved in water, are taken up by plants through their roots, usually as food.

While not forming a part of the soil, strictly speaking, there are in it great numbers of very small plants, especially in the upper six or eight inches. They are spoken of as bacteria, molds, and algae. Many of them are very important because, by their action, some of the plant foods and perhaps most, if not all of them, are prepared for the use of our higher plants. So important are they that the wise farmer handles his soils with a view to keeping their numbers as great as possible.

The mineral matter and organic matter in our soils are found in varying quantities. In our cultivated upland soils the organic matter will amount to from 3% to 6% of the total dry weight of the soil. In our muck soils the amount of organic matter is much greater, some times reaching 97% or 98%. Such a soil is worthless for cropping purposes.

All soils contain moisture in some condition.

THE WATER OF THE SOIL.

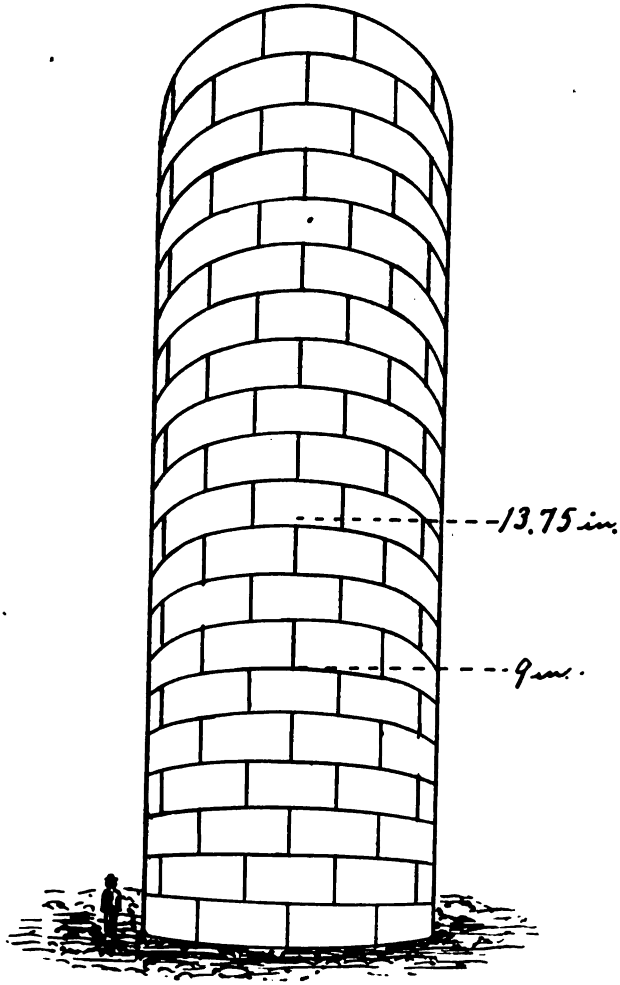
A soil may have in it too much water, or it may have too little water, or it may have just the right amount of water for the best germination of seeds and the best growth of plants.

To discuss the management of soils so that they shall hold the most nearly proper amounts of moisture for crop production and at the same time retain these amounts as far as possible from unnecessary losses is the object of this bulletin.

When water stands upon the surface for any considerable time at any season or within three feet of the surface during the growing season, the land should be drained—preferably tile drained. When soils take on the appearance and feel of dryness, although they may still contain a measurable amount of moisture, they have reached a point where they will no longer yield moisture to the growing crop.

CAPILLARY MOISTURE.

Capillary moisture is the visible moisture which clings to the walls of the soil grains or remains suspended in the smaller openings between the grains. Capillary moisture does not occupy all the pore space of a normal soil and therefore leaves room for the entrance of air into the soil. But there may be too much capillary moisture in a soil or too little for the best growing of crops.



CUT 1.

The reservoir in Cut 1 is 100 feet high, and 37.25 feet in diameter, and will hold 3,400 tons of water. This is equivalent to 30 acre-inches of rainfall. 13.75 acre-inches, the average rainfall of our growing season, fills the reservoir to the point indicated.

Nine acre inches, completely utilized, would produce a yield of:

30	bushels of wheat, or
57.45	bushels of oats, or
107.14	baskets of corn, or
42	bushels of barley, or
437.9	bushels of potatoes, or
2.03	tons of clover hay, or
4.33	tons of corn fodder, or
11.4	tons of ensilage.

THE IMPORTANCE OF SOIL MOISTURE.

The plant obtains all of its food, excepting carbon, from the soil or through it. In nature all these excepting a part of the nitrogen are derived from the soil materials, both mineral and organic, of which they form a part. These foods are dissolved in the soil water and the water with its dissolved materials is taken in through the roots of the plant and thence conveyed to the leaves where the food materials are reconstructed and much of the water thrown off into the air. From the leaves the remaining water with the reconstructed food moves out through the plant to the growing parts where the food is transformed into plant tissue or is stored for future use.

But the food materials in the soil before they can be dissolved by the water must undergo a change by which they are made soluble. Whatever this change may be, water is one of the agents by which it is produced.

Water then is important:

1. In the changing of plant foods into soluble form.
2. To dissolve and convey plant foods to and into the roots of the plant.
3. To convey plant foods from the roots to the leaves for elaboration.
4. To convey the elaborated foods from the leaves to other parts of the plant for use.

Nothing has been said of the importance of water in the germination of seeds. Without water the seeds would not swell to burst the coat, nor could the food stored in the seed be transformed, dissolved, and transported to the different parts of the young plant.

It requires large quantities of water to dissolve and convey the food to plants. To produce one pound of dry matter of crop requires the passage into the plant of from nearly 300 pounds to nearly 500 pounds of water. See Table II.

An inch of rain on an acre of ground (one acre-inch) weighs about 113.4 tons.

CONDITIONS INFLUENCING AMOUNT OF CAPILLARY WATER.

The amount of capillary water a soil will hold will depend upon:

1. The size of the mineral particles in the soil.
2. How these particles are combined into compound grains.
3. The amount of organic matter in the soil.
4. The degree of mellowness, or the tilth of the soil.

1. The finer the grains in a soil the greater is its water-holding power, other things being equal. This is true because the finer the particles of soil the larger the total surface the grains of a given weight of soil will present for the moisture to gather upon. For example, one pound of marbles one-half inch in diameter will present just twice as great total surface as one pound of marbles one inch in diameter, and theoretically would hold twice as much water on their combined surfaces under the same conditions if not in contact. If in contact they would probably hold more than twice as much.

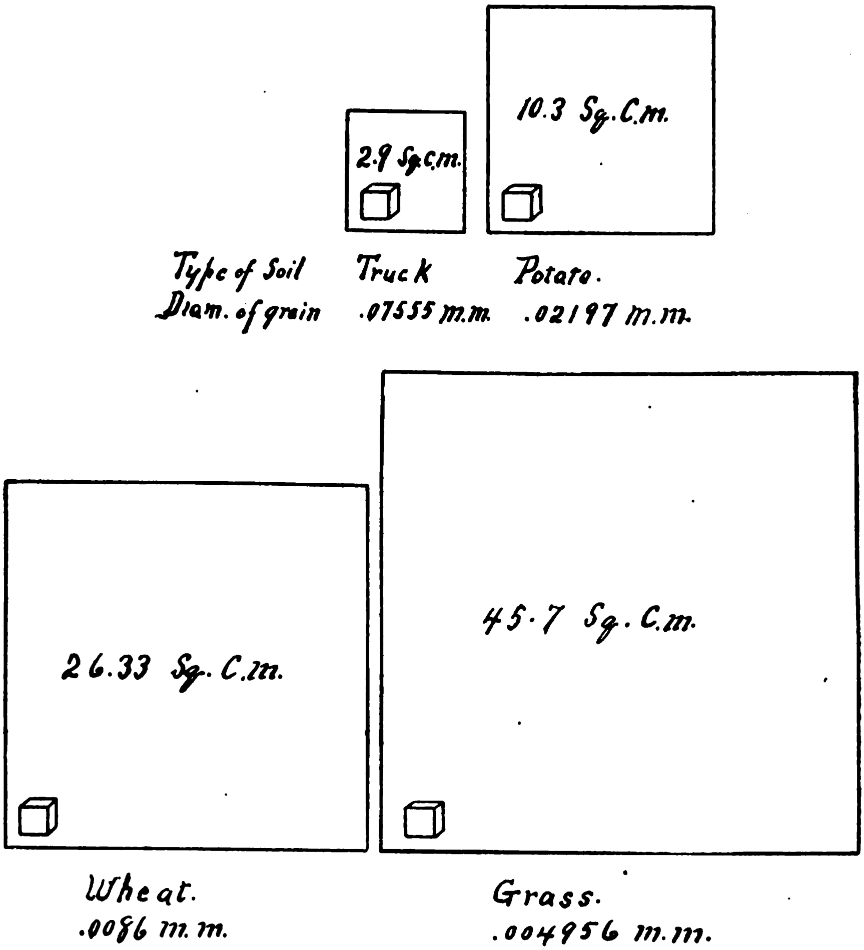
If the surfaces of all the grains in a cubic foot of some of our finer soils could be measured they would be found to amount to as much as four, five and sometimes more than five acres—five acres of surface to which water may cling, and all this in a single cubic foot of soil.

Cut II shows in a graphic way how the total surface varies with the size of soil grain. The four squares represent the exact total surface of one-tenth of a gram, =.0035 of an ounce, respectively of a typical truck soil, a typical potato soil, a typical wheat soil, and a typical grass soil. The average diameter of the soil grain is indicated in each case. A millimeter (mm.) is about one twenty-fifth of an inch.

The small cube in each square represents closely the volume of one-tenth gram of the soil indicated.

The figures in the squares indicate the actual areas of the squares.

A cubic foot of the truck soil would have a total surface of about .3 acre, while a cubic foot of the grass soil would have about 4.12 acres.



CUT II.

2. What appear to be grains of soil in mellow loams and clays are usually not grains, but crumbs—composites consisting of tens, hundreds, and even thousands of individual or simple grains, held together partly by cementing materials in the soils and partly by water contained in the composites. Not only does the water help in developing this crumb-like condition, but a soil in this condition will hold naturally the largest possible amount of water for the use of crops, and at the same time will retain larger amounts from loss by percolation and evaporation.

3. The organic matter in a soil and especially the humus acts as a sponge would act. Its relative capacity for holding water is considerably greater than that of the mineral matter as you may have observed. Hence the importance of returning to our soils, especially to our loams, clays, and sandy soils, as much of the roughage of the farm as possible, and hence, also, the importance of following a careful rotation which shall result in part in an abundance of root material in the sub-soil.

Good applications of barnyard manure increase the water-holding power of soils.

Experiments in our laboratory show that when water is passed:

through 100 ozs. of an air dry clay soil, 56 ozs. were retained,
through 100 ozs. of an air dry loam soil, 49 ozs. were retained,
through 100 ozs. of an air dry sandy soil, 36 ozs. were retained,
through 100 ozs. of an air dry muck soil, 170 ozs. were retained.

In the first three cases the differences are due largely to the size of the soil grains. In the fourth case the great capacity of the soil for water is due to the large amount of organic matter present. The organic matter in this particular soil amounts to over 69%.

The presence of organic matter in a soil favors the development of the crumby structure discussed above.

4. The importance of the manner in which the simple grains of soil are combined into composites, or crumbs, has been discussed under (2). The manner in which these composites are arranged in the soil mass—whether the soil is loose and open or whether hard and compact—is even more important.

If one takes the trouble to examine a productive virgin soil, he will find in it a natural mellowness, which still exists for a time after the soil is brought under cultivation. To this mellowness is due in no small degree the large crops which such a soil yields.

On the other hand a soil cropped continuously and carelessly handled for some time, is found to be lacking in this mellowness. It no longer produces good yields, and largely because it lacks mellowness, and largely because in this condition it is unable to gather and retain the moisture needed for crop production.

In a mellow soil each crumb becomes a reservoir filled with food-laden moisture, and through the openings or archways separating these crumb masses from each other the roots of plants may readily travel, thus finding ready access to the moisture and food stored in the crumbs.

The really productive soils are those possessing the mellowness found in our virgin soils and they possess it because proper methods are employed in their tillage. These include a proper rotation of crops, the incorporating of an abundance of organic matter in the soil, and the wise use of tools.

Nature, left to herself, provides a crop, and usually a rotation, for the soil in which:

1. The soil is filled with roots—often perennial roots which, with frost action, develop the crumbed and mellow or arched structure.

2. The bulk of the growth is returned to build up and enrich the soil. Bees may remove the nectares, birds may remove the seeds and grazing animals may crop off the grasses, but after all the roughage with much of the fertilizing material is returned to the soil. The wise farmer profits by the object lesson.

Nature, however, has need of no other tools than the roots and frosts and the multitude of animal forms which burrow in the soil,—earth worms, ants, etc. The farmer must use the plow, harrow, roller and other tools. With the proper moisture conditions these tools may be made to help develop the mellow condition sought. Every farmer should learn to recognize this proper moisture condition and to appreciate its importance. If the soil be too wet the use of these tools may prove injurious rather than helpful. If a cultivated soil be allowed to become over dry, the drying often produces a degree of compacting that the use of these tools cannot overcome.*

RAINFALL.

The average annual rainfall for Michigan is about 30 inches. This equals 3,400 tons of water on every acre of land. See Cut I .

Our average rainfall during the growing months—April, May, June, July and August, for the fifteen years, 1888 to 1902, inclusive, was 13.75 inches and was distributed as shown by Table I.†

* See article "The Puddling of Soils," p. 85, Farmers' Institutes 1902-1903.
† This data was obtained through the courtesy of Mr. C. F. Schneider, in charge of the U. S. weather observing station at Grand Rapids.

TABLE I.—*Showing the distribution of rainfall during the months of April, May, June July, and August, 1888 to 1902.*

Section of State.	April.	May.	June.	July.	August.	Total for locality.
Upper Peninsula	2.20	2.96	3.10	2.94	2.82	14.02
Lower Peninsula						
Northern counties	2.04	2.91	2.95	2.75	2.72	13.37
Central counties	2.03	3.28	2.73	2.73	2.71	13.48
Southern counties	2.11	3.37	3.43	2.91	2.36	14.18
Average of sections	2.09	3.13	3.05	2.83	2.65	13.75

CROP POSSIBILITIES IN THE RAINFALL OF OUR GROWING SEASON.

From tables given by Professor King in his Physics of Agriculture and in the Wisconsin Experiment Station literature, Table II is deduced for the purpose of indicating the size of crops possible if our rainfall could be completely utilized.

According to the table the average rainfall for the growing season is completely utilized for crop growing would produce much larger yields than are those now grown on the average farm of Michigan, but it is not utilized completely by our crops because:

TABLE II.—*Showing crop yields possible for different amounts of rainfall completely utilized.*

Rainfall.	Bushels wheat per acre.	Bushels oats per acre.	Baskets corn per acre.	Bushels barley per acre.	Bushels potatoes per acre.	Tons of clover hay per acre.	Tons of ensilage per acre.	Tons of corn fodder per acre.
4 inches	13.5	25.53	47.62	18.69	194.1	.90	5.07	1.92
5 inches	16.66	31.91	59.54	23.36	242.7	1.128	6.44	2.40
6 inches	20.00	38.30	71.44	28.04	291.2	1.354	7.60	2.88
7 inches	23.33	44.68	83.34	32.71	339.8	1.58	8.87	3.36
8 inches	26.66	51.06	95.24	37.38	388.4	1.80	10.14	3.84
9 inches	30.00	57.45	107.14	42.05	437.9	2.03	11.40	4.33
12 inches	40.00	76.59	142.76	56.07	582.5	2.71	15.21	5.77

1. A portion is usually lost by surface drainage.
2. A portion sinks into the ground beyond the reach of the roots of the crops.
3. A portion rises again to the surface by capillarity, evaporates, and is carried away by the atmosphere.
4. The rainfall is often unevenly distributed.

If the soil were in proper condition, as set forth above:

(a) The losses by surface drainage and by percolation would in many cases be entirely prevented, where they are now considerable, while,

(b) In all cases the losses from all four sources would be materially lessened.

We have already spoken of the capacity of some soils for capillary water as determined in the laboratory. But these amounts would probably vary greatly under field conditions. Some data given by Professor King in his Physics of Agriculture indicate that after draining a few days after heavy rains the first five feet of a sandy loam might contain the equivalent of 10 inches of rainfall, a clay loam 15 inches and a muck soil probably considerably more than either.

It hardly needs to be said that not nearly all of this supply is available for crops. At the same time, even in rather sandy soils, intelligent tillage will accomplish some remarkable results with this store of soil moisture.

In 1897 the writer visited a field of rather coarse soil, which yielded 9.15 bushels of spring wheat per acre. The rainfall during the growing season was:

¼ inch in May,
¾ inch in June,
1-16 inch in July, and
1-16 inch in August.

The rainfalls of July and August were hurtful rather than helpful.

THE IDEAL MOISTURE CONDITION.

When a soil contains about (usually a little more than) half the greatest capillary quantity it is capable of holding, it is in the best possible moisture condition for both the germination of seed and the growth of crops.

PRACTICE.

We have already indicated what may be done to give to the soil its maximum capacity for capillary water. But after this is accomplished certain methods of moisture management are necessary. These call largely for the intelligent use of farm tools. This is an art and a great art which every farmer should master.

TO DISPOSE OF EXCESSIVE MOISTURE.

1. As has already been stated, a soil may contain an excessive amount of capillary moisture and it is not always desirable or convenient to wait for its removal by natural means. The farm tool must be brought into use. It is presumed that the land is drained—best tile drained. If it is not and this excessive moisture is common, not many seasons should pass before it is drained.

(a) If the land has not been plowed, then the plow will probably be the tool used. If the soil be a clay or a clay loam.

1. Use a plow with a slanting mold board and do not plow deep; for the abrupt mold board and deep plowing will both have the effect of unduly packing the soil when over wet, which should be avoided.

2. After plowing, do not allow the soil to dry too long before it is gone over with a spike-tooth harrow or better, under some conditions, with a roller followed shortly by a spike-tooth. The object of the harrowing is to prevent the forming of hard lumps at the surface in the drying of the soil, as is almost sure to occur in the soils named if allowed to dry too long before a mellowing tool is used. It is easy enough to tell by feeling or even by the eye when this mellowing process should begin. It is not practiced as much as it should be.

The use of the roller as suggested will often improve the quality of the mellowing, but in any case will bring the newly plowed soil in more complete contact with that below which is a thing to be desired in spring plowing and will at the same time improve the capillary conditions of the newly plowed soil.

(b) If the soil has already been either fall or spring plowed, then the use of one of two tools may be suggested:

1. If the soil is loose the roller may be used. Its use will more thoroughly compact the soil grains, and moisture will rise more rapidly through a reasonably compacted soil than it will through a more open one. When a roller is so used, care should be taken not to allow the drying to go too far, for in such a case the surface may become over dry and even cloddy. At the proper time some stirring tool should be used. The use of the roller for this purpose should be exercised with much care.

2. The disc harrow may be used. The use of the disc will bring the more moist layers of soil to the surface and thus expose them to the action of the sun and wind.

There is less danger in using the disc than in using the roller, but even here intelligence needs to be exercised and the spike-tooth used at the proper time.

TO PREVENT MOISTURE LOSSES BY EVAPORATION.

A more important question with most farmers, though one not always appreciated, is how to prevent losses of moisture by evaporation. These losses are often greater than most of us realize.

Losses by evaporation, when the upper soil is well supplied with moisture, may amount to an inch of water in four days. In our laboratory with little sunshine and no heavy drafts, moisture evaporates from an uncultivated surface 24 inches above standing water at the rate of one inch in 13 days. Reference to Table II will show what such a loss means to crop production.

Cultivation is the means usually employed to prevent evaporation losses.

The experiments conducted at the Wisconsin Experiment Station and described in their report for 1898, show how different the results of the same series of cultivations upon clay and muck soils.*

By cultivation is meant any stirring or loosening of the upper layer of the soil, and may be accomplished by means of the plow, harrow, weeder or cultivater.

Water cannot rise so rapidly through a loose soil as through a compact one.

Generally the deeper the stirring the more complete the saving of moisture. In a laboratory experiment in which the soil surfaces were 24 inches above standing water one cultivation 1 inch, 2 inches, 3 inches and 4 inches deep respectively, resulted in savings over no cultivation, as shown in Table III.

In this case it is seen that the deeper the cultivation the greater the saving of water. This will be true for all soils probably.

TABLE III.—*Showing effectiveness of different depths of a single cultivation during a period of 21 days.*

Depth of cultivation.	Losses in tons per day.	Losses in inches.	Per cent moisture saved.
0 inches	10.4	1 inch in 10.89 days]	0
1 inch	5.19	1 inch in 21.83 days	50.6
2 inches	3.36	1 inch in 33.72 days	67.7—
3 inches	3.16	1 inch in 35.85 days	69.6+
4 inches	2.86	1 inch in 39.61 days	72.5

It is generally believed that the more frequent the cultivations the greater the saving of moisture. Gnerally speaking this is true so far as studied for clays, loams, and possibly for sandy soils. It is not true for all soils. Soils rich in organic matter, such as the muck soils, profit by single cultivation, but so far as studied frequent cultivations do not promote the further saving of moisture.†

In practice it is found that, with cultivated crops on the soils indicated, frequent cultivations with cultivator, harrow or weeder, not over 2 inches deep, prove most satisfactory.

It is found, too, in practice, that those who are most persistent in frequent shallow cultivating find it profitable practice.

HARROWING GRAIN.

The harrowing of grain crops is coming a good deal into favor. Going over the winter wheat field one or more times in spring with a spike-tooth harrow is fcund to give good results. Some farmers in the west practice harrowing their grains until they are so high as to be apparently considerably broken down by the harrow bars.

THE DRY EARTH MULCH.

A layer of dry soil is much more effective in preventing moisture evaporation than a layer of like depth of moist soil, and so it is sought by many, in practice, to develop by frequent cultivations a shallow dry earth mulch or "blanket," using the harrow, weeder, and later, the many-toothed cultivator.

* Michigan Farmers' Institute Report (p. 12), 1900-1901.
† See Michigan Farmers' Institute Report, 1900-1901, p. 12, and current report (1903-1904).

USING THE ROLLER ON GRAIN.

The use of the roller upon a field of grain after the grain is well up gives excellent results in cases where the surface is lumpy and dry. The reason lies largely in the fact that in crushing the lumps a dry earth mulch is developed to lessen the evaporation while the packing of the soil may have the effect of improving capillarity below.

TO BRING MOISTURE NEARER THE SURFACE.

It sometimes happens that because of the looseness of the soil, water is not brought up sufficiently rapidly into the seed bed, or it may be that the evaporation from the surface is so rapid that the moisture from below cannot move upward rapidly enough to balance these evaporation losses. The result in either case is an insufficient amount of moisture in the upper soil.

1. A well developed mulch would reduce the evaporation losses, and since water moves more rapidly through moist soil than through dry, the tendency would be to accelerate the upward movement of moisture and in time to accumulate an abundance of it in the upper soil.
2. Rolling the land would compact the soil and thus increase the upward movement of moisture from below. The roller should be followed by some mellowing tool to develop a surface mulch and thus to lessen surface evaporation.
3. Had this soil received good dressings of manure, and the same been well incorporated in the soil, its presence would have had the effect both to gather moisture from below and to prevent its loss by evaporation.

DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP FOR FATTENING SHEEP.

BY R. S. SHAW.

Bulletin No. 220.

Two years ago dried beet pulp was placed on sale in large quantities in various Michigan markets. One year later dried molasses-beet-pulp was also offered for sale to stock feeders. The wide distribution of these materials and the large quantities used have created a demand for information concerning their feeding value for various classes of animals.

The objects of these experiments have therefore been as follows, viz.:

(1.) To determine the feeding value of dried beet pulp compared with corn.

(2.) To determine the feeding value of dried beet pulp when used in conjunction with grain rations.

(3.) To determine the relative feeding values of dried beet pulp and dried molasses-beet-pulp.

Two of a series of tests have been completed. In the 1902 and 1903 tests, dried beet pulp only was used; in the 1903 and 1904 tests, both kinds of pulp were used.

The following is a detailed description of the tests of 1903 and 1904.

THE ANIMALS USED.

On December 18th, 1903, ninety western lambs were purchased in Chicago, averaging 61.1 lbs., at a cost of $4.60 per cwt. When delivered at the Michigan Agricultural College, on December 20th, these lambs averaged 58.8 lbs., having

shrunk 2.3 lbs. in transit. On January 19th, 1904, when the experiment proper began, these lambs averaged 67.38 lbs.; at the close of the experiment, April 12th, eighty-five days later, they averaged 96.03 lbs. On April 16th, the lambs were shorn, producing an average of 6.56 lbs. of wool per head. On May 16th, at the time of shipment, the lambs averaged 99.88 lbs. During the time stated, no less than 47.6 lbs. per head was added to the 58.8 lb. lambs with which the feeding operations began.

METHODS OF FEEDING AND HANDLING.

The lambs were enclosed continually, there being no access to yards, each lot of eighteen being confined in a space 14x16 ft. Both grain and hay were supplied twice daily, the latter being fed in the same racks after the former had been consumed. Constant access to rock salt and water was provided, plenty of fresh air was supplied, and the proper temperature maintained as far as possible. From the beginning of the preliminary period, December 24th, 1903, the lambs were started on the rations used during the test proper. They were first given .25 lb. concentrates per head daily, which was gradually increased, a slight increase being made each day. From January 19th to February 16th, the first twenty-eight days of the test proper, the lambs consumed an average of 1.01 lbs. concentrates per head per day; during the second twenty-eight days, from February 16th to March 15th, the amount reached 1.24 lbs., and during the last twenty-nine days, extending to April 13th, 1.60 lbs. We consider the gradual increase in the grain ration from day to day, and light feeding during the preliminary period, to be two of the most important factors in successful and economical sheep feeding.

Clover hay was supplied according to the needs of the lambs after consuming their various rations of concentrates. The weights hereafter given consist of the average of three consecutive days' weights, and date from the second weigh day.

Of the ninety lambs used in this test, not one was off feed for a single meal during the eighty-five days, nor could any ill-doers be found among them.

THE RATIONS.

The following are the rations used during the experiment, the proportions being given by weight:

For Lot I. Corn 4 parts, bran 2, linseed meal 1; cost per cwt. 97c.
For Lot II. Corn 4 parts, bran 2, linseed meal 1, beet pulp 7; cost per cwt. 77c.
For Lot III. Dried beet pulp 4 parts, bran 2, linseed meal 1; cost per cwt. 78c.
For Lot IV. Dried molasses-beet-pulp 3 parts, linseed meal 1; cost per cwt. 86c.
For Lot V. Dried beet pulp 3 parts, linseed meal 1; cost per cwt. 78c.

The following food valuations represent the actual cost of the food stuffs, nearly all of which, with the exception of the clover, were purchased in the open market: Linseed meal, $28.00 per ton; bran, $18.00; corn, $18.00; dried molasses-beet-pulp, $13.70; dried beet pulp, $11.60, and clover hay, $5.00.

THE PRELIMINARY FEEDING PERIOD.

During this period of twenty-six days from December 24th, 1903, to January 19th, 1904, the rations used for the five lots of lambs were the same as those heretofore described, and the following amounts were consumed by the various lots of eighteen each:

Lot I. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
Lot II. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
Lot III. consumed 744 lbs. clover hay and 295.5 lbs. concentrates.
Lot IV. consumed 698 lbs. clover hay and 295.5 lbs. concentrates.
Lot V. consumed 730 lbs. clover hay and 295.5 lbs. concentrates.

During this period the consumption of concentrates was the same in every case, amounting to .63 lb. per head per day. Where, however, the two kinds of pulp were used in largest proportion for Lots IV and V, these lambs failed to consume as much hay as the others. The total cost of the food consumed during this period

was $21.42, and, considering the large gain made, the cost of production was small. The fact, however, that the first weights were taken after a shrink, tended to increase the apparently normal gains.

Food consumed by the various lots during the 85-day experiment from January 19th to and including April 12th.

	Pounds.	Clover hay, pounds.	Cost.
Lot I. Concentrates (corn, bran, and linseed meal).............	1950.75	2353.00	$24 82
Lot II. Concentrates (corn, bran, linseed meal and dried beet pulp)..	1950.75	2147.00	20 48
Lot III. Concentrates (dried beet pulp, bran and linseed meal)....	1950.75	2301.75	21 12
Lot IV. Concentrates, (dried molasses-beet pulp and linseed meal)	1950.75	1987.00	21 80
Lot V. Concentrates (dried beet pulp and linseed meal)	1950.75	2143.75	20 67

The amount of concentrates consumed in each case was exactly the same, averaging 1.27 lbs. per head daily, for the period. The variation in the actual amounts of roughage consumed is apparently due to the presence of pulp in the ration, less hay having been consumed where the most pulp was fed. The average daily consumption of hay per head ranged from 1.27 lbs. in Lot IV to 1.53 lbs. in Lot I.

The above figures represent the actual amount of clover hay consumed. After each feed, the racks were carefully cleaned and the refuse roughage collected and weighed at intervals. The waste, which consisted mostly of grain stubble and some woody stems, amounted to 6.38% of the entire roughage supplied. As the clover hay was of good quality, it was almost entirely consumed, much care being exercised in supplying about the proper amount at each feed. If the hay is coarse and of poor quality, too close feeding may become forced feeding and interfere with the gains.

Weights and increase in live weight during the 85-day test.

	Weight Jan. 19, 1904. Pounds.	Weight April 12, 1904. Pounds.	Grain. Pounds.	Cost per cwt. gain.
Lot I. 18 lambs..............................	1189.3	1695.6	506.3	$4 88
Lot II. 18 lambs	1226.0	1759.3	533.3	3 84
Lot III. 18 lambs..............................	1218.0	1722.6	504.6	4 18
Lot IV. 18 lambs..............................	1205.3	1730.3	525.0	4 15
Lot V. 18 lambs..............................	1226 3	1735.3	509.0	4 06

Daily, weekly and monthly gains.

	Per day. Pounds.	Per week. Pounds.	Per month of 30 days. Pounds.
Lot I. Gain per head..................................	.330	2.31	9.90
Lot II. Gain per head	.348	2.43	10.44
Lot III. Gain per head	.329	2.30	9.87
Lot IV. Gain per head..................................	.343	2.40	10.29
Lot V. Gain per head..................................	.332	2.32	9.96

CORN AND DRIED BEET COMPARED.

The concentrates of the ration for Lot I consisted of corn 4 parts, bran 2 and linseed meal 1, while those for Lot III consisted of dried beet pulp 4 parts, bran 2, and linseed meal 1. Exactly the same amount of concentrates was consumed in

both cases, but Lot I consumed 51.25 lbs. more clover hay than Lot III, a slight advantage in its favor as to total quantity of digestible nutrients consumed, but even this could not have made a difference of more than four or five pounds in the increase in live weight. As the total gain from Lot I was 506.3 lbs. and that from Lot III was 504.6, the former exceeded the latter by only 1.7 lbs. When we consider that thirty-six lambs were used in this part of the test, and that the feeding period continued eighty-five days, this small difference in gain in live weight cannot be considered. The only inference we can make in regard to the relative feeding values of dried beet pulp and corn, judging from the results of this one experiment with lambs, is that they are practically equal. As to the cost, one cwt. of increase in live weight from the corn ration cost $4.88, while the same increase from the pulp ration cost but $4.18, a difference of 70 cents in favor of the latter, but as the values of corn and pulp are subject to fluctuation, this is not a stable basis on which to fix a comparison.

GRAIN MIXTURES ALONE VERSUS GRAIN MIXTURES PLUS EQUAL AMOUNT OF DRIED BEET PULP BY WEIGHT.

The ration of Lot I consisted solely of grain and grain by-products, viz.: corn four parts, bran 2 and linseed meal 1, while the ration for Lot II consisted of corn 4 parts, bran 2, linseed meal 1, and dried beet pulp 7, or, in other words, equal parts of grain mixture and beet pulp. Precisely the same amounts of concentrates from these two rations were fed to the two lots of lambs during the experiment, but Lot I receiving the grain mixture, consumed 206 lbs. more clover hay than Lot II, one-half of whose ration consisted of beet pulp. As Lot I gained but 506.3 lbs. and Lot II 533.3 lbs., the latter produced 27 lbs. more mutton, and at a cost of $1.04 per cwt. less than the lot receiving the grain ration without pulp. In fact, a perusal of the data given shows the lot of lambs receiving the grain and pulp mixture to have made not only the largest gains of the five lots, but to have produced these gains at the lowest cost. This is quite in accord with the popular belief that the sheep gives best returns from a variety of foodstuffs, and it is possible that the beet pulp may have acted as a stimulus to the vital functions of the animals.

Along this same line, the data from a preceding year shows similar results. During the winter of 1902 and 1903, two lots of wethers of fifteen each and also two lots of lambs of ten each were fed on a similar plan.

TEST WITH THE WETHERS.

Fifteen yearling wethers comprising Lot I were fed forty days on a grain ration consisting of corn 4 parts, bran 2 and linseed meal 1. Of this grain mixture they consumed on the average 2.48 lbs. per head per day, and 1.41 lbs. clover hay. The fifteen wethers of Lot II received a ration containing the same grain mixture, to which dried beet pulp was added to the extent of eight-nineteenths of its weight. Of this combination they consumed 2.48 lbs. per head per day, and 1.41 lbs. of clover hay. Lot I in the forty days gained 256 lbs. at a cost of $7.87 per cwt., while Lot II, receiving the grain mixture containing pulp, gained 275.3 lbs. in the same time at a cost of $6.35 per cwt.

TEST WITH THE LAMBS.

The two lots of lambs of ten each also fed in 1902 and 1903 consumed rations duplicating those just described for the wethers. The lambs of Lot I consumed 1.9 lbs. of the grain mixture without pulp and 1.42 lbs. of clover hay daily. Lot II, receiving the grain mixture with pulp added, consumed 1.9 lbs. of concentrates and 1.39 lbs. of clover hay daily. The first lot gained 160.3 lbs. during forty days at a cost of $5.33 per cwt., while the second lot gained 140.6 lbs. during the same time at a cost of $5.29 per cwt. In this one instance, the largest gain was made by the lot of lambs receiving the grain mixture without pulp, but the cost of production was less where pulp was used in the ration. In the 1902 and 1903 tests, the rations of concentrates were so exceedingly large that comparative results with striking differences were not expected. In these earlier tests the foods were valued at practically the same prices as in the later ones.

DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP COMPARED.

Referring again to the data secured from the 1903 and 1904 experiments, we find that the eighteen lambs of Lot IV received a ration of concentrates consisting of dried molasses-beet-pulp 3 parts and linseed meal 1 part, while the ration of Lot V containing the same number of lambs consisted of dried beet pulp 3 parts and linseed meal 1 part. During the eighty-five day test, the lambs receiving dried molasses-beet-pulp gained 525 lbs. and those receiving dried beet pulp 509 lbs., an increase of 16 lbs. in favor of the former. The amounts of concentrates consumed were exactly the same, but the lambs receiving dried beet pulp consumed 156.75 lbs. more clover hay. The cost of grain per cwt. was $4.15 where molasses-beet-pulp was used, and $4.06 with the dried beet pulp. Though the former made slightly the larger increase in live weight in this instance, it was not sufficient to offset the additional cost of the molasses-beet-pulp. Observations concerning the relative palatability of these two foodstuffs have been made from time to time in which sheep seem to show a preference for the dried molasses-beet-pulp.

ANALYSES OF DRIED BEET PULP AND DRIED MOLASSES-BEET-PULP, WITH COMMENTS ON THE SAME BY MR. FLOYD W. ROBISON, EXPERIMENT STATION CHEMIST.

(The samples taken for analysis were secured by saving a small amount of pulp from that used each week during the experiment in mixing the rations. The composite sample therefore, contained material from twelve different lots.)

No. B 466, dried molasses-beet-pulp.

No. B 467, dried plain white beet pulp.

	No. B 466 per cent.	No. B 467. per cent.
Moisture	9.160	9.860
Ash	5.976	3.876
Protein (total)	9.389	7.722
Proteids (true)	6.845	7.547
Amids	2.544	0.175
Crude fiber	14.700	18.650
Fats	1.540	1.140
Carbohydrates	59.235	58.752
Sugars (total)	23.000	10.580
Cane sugar	16.380	7.220
Dextrose	6.620	3.360
Fuel value in calories per gram	3802.44	3812.50

"It will be noted that the molasses-beet-pulp carries a slightly lower percentage of water than does the plain white pulp. It should be a trifle more economical and desirous from this standpoint. It will again be noticed that the molasses pulp contains more total protein than does the plain pulp. This seems to be caused by the high percentage of amido bodies in the molasses, such an amount, in fact, as to make the per cent of true proteids in the molasses pulp considerably less than in the white pulp. It has been customary to consider the amido bodies to have practically no feeding value and from this standpoint the plain white pulp would of course be superior. It has seemed to me, however, that, inasmuch as many of the amido bodies make good culture media for bacteria, they might be considered as 'sparers' of true proteid in which case we should be compelled to give them a value in the ration. This value cannot, however, equal the value of a true proteid. From the standpoint of fiber, the molasses pulp is again somewhat superior to the plain pulp in that it contains a less amount of this material. It seemed quite reasonable to suppose that the higher the fiber content in a feed the less will be the net available energy of that feed."

"The other point in which the laboratory analysis shows a difference is in the amount of sugars present in the samples. It will be noted that the molasses pulp contains slightly more than twice as much total sugar as does the plain pulp. This should tend to increase the net available energy of the molasses pulp. It is doubtful if the presence of a greater per cent of sugar in the molasses pulp can be said to in any way increase the digestibility of that pulp. Whether the

carbohydrate bodies are partially digested or not seems to make but little difference, if any, in the total per cent of digestible matter. It is certain, however, that the feed showing the higher content of soluble carbohydrates would furnish more available energy to the animal. It is surely certain that such feed must be utilized at less cost to the animal system. On the whole the analysis seems to indicate a slightly higher value for the dried molasses-beet-pulp. It would be difficult to express this difference in actual money values, but the fact that all or nearly all of the differences are in reality but slight ones would not justify the giving of a very much greater value to molasses-beet-pulp."

SLAUGHTER TEST BY ARMOUR & CO.

Armour & Co., in submitting the figures, state: "The yield (dressed weight) is figured on the basis of 3% cooler shrink and the tallow is not considered in this weight, the figures given being net."

Result of test.

	Live weight. Pounds.	Dressed weight. Pounds.	Dressed. Per cent.	Tallow. Pounds.
Lot I	1560	818	52.43	117
Lot II	1600	835	52.18	165
Lot III	1550	803	51.81	132
Lot IV	1570	835	53.18	128
Lot V	1560	805	51.60	161

Only seventeen lambs from each lot were placed upon the market, one average individual from each pen being slaughtered at home in order to secure illustrations from the carcasses and cuts. These lambs sold on the market at $6.10 per cwt., $6.15 being the top price for the day. The day before shipment, the ninety lambs averaged 99.8 lbs. Eighty-five of these were sold on the market at 92.2 lbs. There was a large shrinkage, due, in part, to the twenty-four hours or more in transit. The ninety lambs netted a profit of $106.65, or $1.18 per head, after accounting for feed and every expense except cost of feeding, which is commonly offset by the value of the manure produced.

AMOUNT OF WOOL CLIPPED FROM THE VARIOUS LOTS ON APRIL 16, 1904.

The shearing was done by machine, by one individual, resulting in uniformity in the work done.

	Weight of wool. Pounds.	Average weight of fleece. Pounds.
Lot I. 18 lambs	109.5	6.08
Lot II. 18 lambs	115.0	6.38
Lot III. 18 lambs	121.5	6.75
Lot IV. 18 lambs	117.25	6.51
Lot V. 18 lambs	128.0	7.11

The concentrates of ration I contained no pulp, those of Lot II were one-half pulp, Lot III four-sevenths pulp, and Lots IV and V three-fourths pulp. With the exception of Lot IV, the production of wool increased with the increase in the amount of pulp consumed. There were, however, other variations in addition to the relative amounts of pulp consumed. Lot I contained corn 4 parts, bran 2 and linseed meal 1, while Lot II contained corn 4 parts, bran 2, linseed meal 1, and dried beet pulp 7; the ration of Lot III, though consisting of four-sevenths pulp, contained no corn. The dried beet pulp of ration V contained more true protein than the dried molasses-beet-pulp of IV. Of course such influences as

slight differences in breeding would tend to affect the wool production, but if these differences existed they could not be detected; the lambs were westerns and consequently were uniform. We have not produced these figures as proof of the fact that the beet pulp stimulated wool production, for our experiment does not prove that fact. These, however, are the results in this instance.

CONCLUSION.

1. These tests seem to indicate that both dried beet pulp and dried molasses-beet-pulp are possessed of feeding values comparing very favorably with corn.
2. That grain mixtures containing dried beet pulp produce more mutton at less cost than similar amounts of grain mixtures alone.
3. That dried molasses-beet-pulp possesses a somewhat higher feeding value than dried beet pulp, but in this experiment the difference was not great enough to offset the difference in price.

PART I.

MILK, ITS PURITY AND ITS IMPURITY.

(How to care for and handle milk.)

CHARLES E. MARSHALL AND W. R. WRIGHT.

Bulletin No. 221.

I. THE SIGNIFICANCE OF PURE OR IMPURE MILK.

Successful dairy farming or successful milk production, as dairy progress becomes better defined, is more and more dependent upon ability, for, with constant and technical dairy development, dairying is fast growing into an exacting profession and those who attempt to play at it or simply to meddle with it will lose in the end. Farmer A may be able to produce good milk, while farmer B cannot; in the former instance, the man is qualified and understands the careful and correct production of milk; in the latter case, the man is not qualified, he is ignorant of the management of milk, and perhaps he is prejudiced in favor of, and determined to adhere to, old usages.

Good milk, good butter, and good cheese are acknowledged to be in great demand, and each brings good financial returns; the production of every quart of good milk and every pound of good butter or cheese is dependent largely upon the care and management of the milk, as well as the condition of the animal from which it is obtained. We shall commonly find that the difference existing between cheap milk and high-priced milk, cheap butter and high-priced butter, cheap cheese and high-priced cheese, lies in the difference in the care and management of the milk. Doubtless the production of good milk costs more than the production of poor milk; still there is generally more profit in the good milk than there is in poor milk.

It will be found, too, that where trouble exists between producer and consumer, between producer and butter-maker or cheese-maker, and even where trouble arises when the farmer tries to sell his butter to the grocer, that the contention is entirely founded upon the improper care of milk; for with good milk we shall find good consumers, with good milk we shall obtain good cream and good butter, with good milk it is possible to make good cheese.

(In Fig. 1, the authors have endeavored to illustrate by actual measurement the germ-content of different milks. Those familiar with estimating the number of germs in milk will appreciate the difficulty of securing numbers which are representative of all conditions and places, but will agree that the plate is approximately true.)

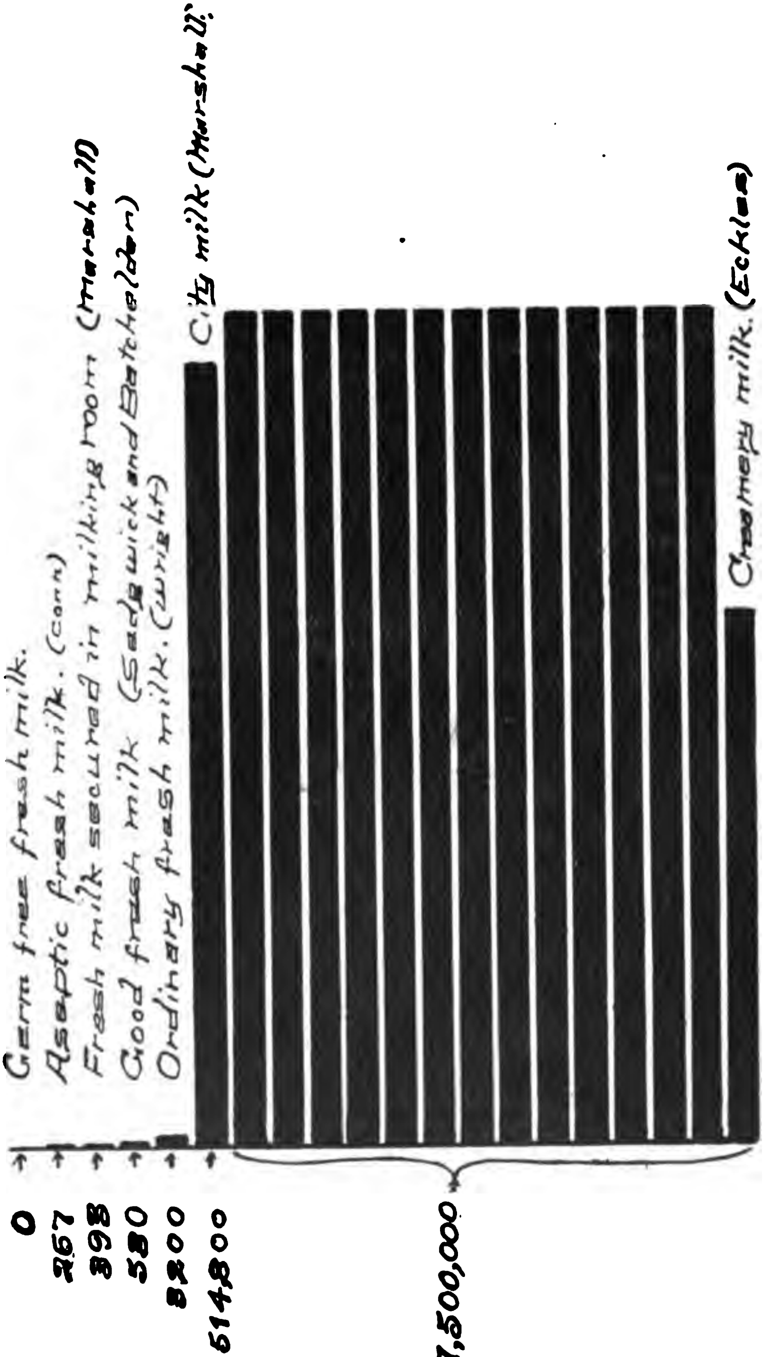

Germ free fresh milk.
Aseptic fresh milk. (Conn)
Fresh milk secured in milking room (Marshall)
Good fresh milk (Sedgwick and Batchelder)
Ordinary fresh milk. (Wright)
City milk (Marshall)
Creamery milk. (Eckles)
0
267
398
530
3200
614800
7,500,000

FIG. I.

If, on the other hand, milk is poor, the butter-maker or the cheese-maker will have to act the part of a physician who attempts to fight small-pox. He may be able to cure in some cases, but he will surely lose in others. If small-pox had been warded off, as it should have been, the physician would not have had trouble and a distasteful experience, and all would have gone well; in the same manner, if poor milk had been kept from the milk of the creamery or cheese factory, neither the butter-maker nor the cheese-maker would have had trouble in manufacturing good products. Consumers will not find fault if the milk is good. Poor milk may be eliminated and good milk substituted, but to do this it is necessary first that the individual be willing to make the effort, and second, that he must know how to direct his forces. It is our purpose to throw out a few practical suggestions. Do not understand that these suggestions must be followed exactly as stated in order to secure favorable results. The man who will be successful in obtaining profit will be able to take this bulletin as a whole, digest it, and utilize its contents under his own conditions. If he cannot do this, it is safe to say that he cannot produce good milk. The man who can pick out the principles and apply them in his own way, being able to cut out the *unnecessary* things and put into practice the *necessary*, will be the man who can produce good milk with little increase in expense over the production of poor milk.

In order to arrive at the full significance of milk, whether pure or impure, it will be desirable to enumerate certain subjects which might fall into the domain of pure milk production. These subjects are: the condition of the animal, whether sound or unsound; the condition of the stable, whether sanitary or unsanitary; the character of the water supply, whether good or poor; the nature of the feed, whether it is nutritious, whether it contains aromatic substances or whether it is unsuitable in any way. Then again, such things as the dust of the stable, the kind of stall, the individuality of the milker, the cleanliness of the pails, the straining of the milk, the aeration of the milk, the cooling of the milk and its further handling—all these matters will have to be taken into careful consideration and dealt with pertinently, rather than exhaustively.

II. TRANSMISSION OF DISEASE IN MILK.

Diphtheria, tuberculosis, scarlet fever, typhoid fever, cholera, choleraic disturbances, sore-throat epidemics have all been traced not infrequently to milk supplies. Those milking or taking care of the milk are generally at fault, for such individuals may be suffering from the disease or may be in communication with some one who has the disease; accordingly, a means of conveyance is provided. There is also the water supply or wash water which may be contaminated with sewage germs or the specific micro-organisms of typhoid fever, or those germs which may produce diarrhoea or sore throat.

The evidence in establishing the transmission of disease through milk is so abundant and so clearly defined that doubt cannot exist in any open mind.

(Fig. II illustrates cheese made from ordinary milk, really better than that usually furnished cheese factories. Note the gas holes produced by micro-organisms.)

(Fig. III illustrates cheese made from good milk secured under practical conditions. Note the absence of gas holes.)

Our suggestion, therefore, relevant to this subject, is that those having communicable diseases, or in any way associated with others having any of these diseases, should neither milk nor handle milk which is consumed by the public. This is a common regulation for the control of public milk supplies.

III. THE INFLUENCE OF FEEDING UPON MILK PRODUCTION.

It is not in our province to discuss the economical methods of feeding milch cows. Rational methods of feeding are fairly understood, or access to such methods may be easily had, and what we have to say applies only to those feeds which may influence the character of the milk. We do find certain food substances which may influence the flavor and aroma of milk. Such substances are ensilage, turnips, rag-weed, leeks, chicory, rape, rye, cabbage, willow, fresh spring grass, potatoes and beet-pulp, and probably many others. It is true that ensilage, turnips, and other food substances may be fed to milch cows without causing any of these obnoxious results, and it is again true that they may be so fed as to produce them.

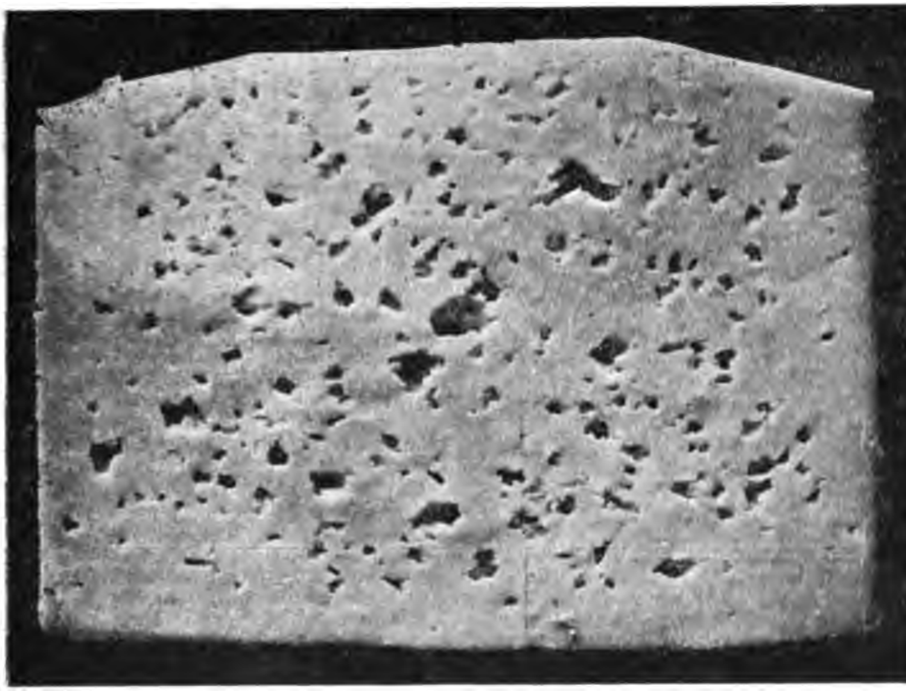


FIG II.

FIG III

Ensilage, for instance, is highly recommended for milch cows and it is doubtless one of the best foods that is known; consequently, feeding must be governed by one's experience, and he can soon learn that there are certain times when these aromatic foods may be taken into the stomach without causing any disturbance in the milk flavor. The quantity fed to each cow, or the time of feeding these foods have to do with milk conditions also. We call attention to these feeds because many times it will be found that some particular odor or flavor in milk may be traced directly to this source or even the character of the milk may be altered.

A certain milk company's regulations may serve to illustrate the significance of feeding for milk production. "All brewers' grain, refuse from distilleries and every kind of fodder which is not in a fresh or good condition is forbidden. Turnips and rutabagas are absolutely forbidden; no kind of turnip leaves is allowed. Vetches are forbidden. Rape-seed cake is the only oil-cake allowed. One and one-half pounds is the furthest limit, and along with it must be at least five pounds of corn and bran. Milch cows furnishing milk for infants must have no oil-cake."

From this it will be understood that attention should constantly be directed to the food given to milk-producing cows because such food may influence the aroma or flavor of the milk or may convey or cause to be conveyed to it substances which may make it unpalatable or even injurious to the drinker. The mother is usually familiar with the facility with which her food may cause disturbance in her nursing child. What is true of the mother is doubtless equally true of the cow. It is only necessary to recall the drastic poison in the cow's milk in milk-sickness or the possibility of poison secretion in milk when animals are bitten by poisonous snakes. While this subject may not be as definite as might be wished, yet there are sufficient facts to guide us in this matter of feeding.

Usually the feeding materials mentioned will not influence the milk seriously if fed two or more hours before milking or immediately after milking, *and sometimes* if fed in limited quantities.

IV. THE CONDITION OF THE ANIMAL, WHETHER SOUND OR UNSOUND.

Much is said, and many inquiries made concerning the production of milk from animals which may be afflicted with disease. This question is legitimate when the disease involves a race rather than individuals, but is not legitimate when it involves only individuals of a herd or individual herds. Tuberculosis is so rife among milch cows in some countries that it is practically impossible to eliminate all diseased animals without doing serious injury to the dairying industry of that country. Under these condtions it may be well to consider very carefully the best means of manipulating milk so that the disease will be curbed among the cattle, and at the same time will not endanger mankind. But when the disease is confined to a single cow of a herd or to a single herd of a community, then it appears that the most rational method would be simply to eliminate the sick animals from the milk-producing list.

Whether it is possible to establish an exact relationship between the disease in the bovine species and in man, is of little moment. It is fair to conjecture that no human being cares to run the risk or to even entertain the thought of drinking milk from a diseased animal. It may be in one case tuberculosis, where transmission through milk has been established, or it may be a case of lumpy jaw where transmission has not been established, or in some other diseased condition of the animal; but whether we know anything at all about the transmission of the disease to man, no matter how we view it, the thought of drinking milk from such diseased animals is obnoxious. No one should be obliged to drink milk from an unsound animal, and no one ought to be so inhuman as to think of it. The first assumption, therefore, is that in order to secure good milk the animal must be sound. It is a regulation of many cities of the United States that cows furnishing milk for the city supply must be sound and free from disease. The tuberculin test in many instances is recommended, but not enforced. The time will probably come when the milk producers will see the economical value of such a test and will voluntarily submit to its application.

V. THE CONDITION OF MILK IN THE UDDER.

For a long time it was supposed that milk in the udder of the cow was free from micro-organisms. This belief was founded upon the fact that some samples of milk drawn under methods which would eliminate contaminations from without, maintained their normal appearance for months. The results, of course, were not always uniform, but if the milk changed, it was supposed that these changes were wrought by accidental contamination. However, upon a closer study of this subject, it has been found that any milk in the udder of a cow contains a variable number of micro-organisms. Ward has made an extensive study of the bacterial content of milk in the udder. He finds several species and a variable number of micro-organisms. Conn, of Connecticut, in estimating the number in a series of tests, places the average number at 267 per cubic centimeter of milk in his so-called aseptic milk. Such milk is doubtless open to outside contamination to some extent. Others, working under similar conditions have gotten results much the same. These germs which are found in the udder belong to different species, and the species are not constant, either in number or kind. We may find germs which do alter milk, and those which do not alter it. Moreover, the number of germs present in milk as it is drawn, will not, as a rule, materially influence the changes in the milk, because it has been found, under practical conditions, that the germs which tend to alter or change the milk are those which enter from without, and the number of contaminating micro-organisms is, of course, in inverse proportion to the cleanliness practiced.

Usually, therefore, the germs which are present in the milk as it is drawn, may be considered in number as negligible, because those who produce pure milk have demonstrated that the keeping qualities of milk are not seriously interfered with by the germs present.

VI. THE CONTAMINATIONS OF MILK FROM WITHOUT.

1. Hairs.—Those who have studied micro-organisms found upon hairs of animals are well aware of the baneful influence they may have upon the changes in milk. A clean hair may have on its surface from fifty to two or three thousand micro-organisms; a dirty hair, almost any number above this. A dirty hair, therefore, entering the milk, may provide micro-organisms by the thousand or by the million. If the milk is strained, and the hair kept on the strainer, the micro-organisms go through just the same, and the surface of the hair is simply washed off. If, accordingly, a milker permits a dozen or two hairs to enter the pail during the course of milking, it means that probably millions of micro-organisms have been introduced into the milk.

Any one at all familiar with the stable is familiar with the character of the dirt on the surface of a hair. There are the micro-organisms which may cause trouble, and are usually capable of producing a variety of changes in milk. They may produce taints or fermentations of any kind.

In order, therefore, to eliminate micro-organisms from this source, it may be necessary to groom the cow thoroughly or to clip the hair on her udder. If the cow is kept clean, and is thoroughly groomed, the necessity for clipping is not so great. Further, by dampening the udder during the milking process, the hair may be made to adhere so that it will not fall into the milk.

2. Dirt.—The dirt that is usually found upon the cow, about the stall, or in the stable, or even on the milker, may contain as many as 80,000,000 germs per gram. About fifty per cent of the dirt that goes into the milk is soluble, the other is insoluble. This latter settles to the bottom. It has been estimated by Backhaus that the people of Berlin consume three hundred pounds of this filth in milk per day. This statement, of course, will assist the reader in understanding the amount of dirt that finds its way into the milk. Whether this dirt comes in the form of little particles of dust, or is adherent to straw, hair, hay or food —no matter how it enters, it is this kind of dirt and filth that contains the greatest number of obnoxious micro-organisms. Even in the seams of the milk pail it is possible to scrape out dried dirt and filth thoroughly loaded with these micro-organisms.

It therefore follows that in order to secure good wholesome milk, we must provide some means of keeping this dirt out. This can be done by means of clean clothes and clean hands for the milker, clean dairy utensils, careful man-

ipulation of the pail and the selection of a clean place to milk; in short, by removing the cow and the milker from an uncleanly environment, the dirty stable, into the open air or a dustless room.

At the present stage of development, many of these maneuvers may be looked upon as impracticable and employed only by those having a single cow in the city; yet these methods have been practiced by actual milk producers, who have aimed at high standards. All that can be said in regard to the practicability of such methods is, if it can be done, the value of the milk will be enhanced; if it cannot be done, have the stable as free from dust as possible, make no disturbance by bedding and feeding previous to milking, exercise as much caution as consistent, and even under these conditions one will be surprised at the results he can obtain from a little effort. Dirt can be eliminated in a degree even in the filthiest places. It rests with the milk producer to determine how far he can go in this matter, and his ability to introduce these desirable methods will depend upon his ingenuity and his sales.

3. The Stall.—It is not pertinent or necessary to discuss the different kinds of stalls in this connection. It is patent that the less surface exposed in the stall the better the stall is for milking purposes. Therefore, a half partition stanchion stall is frequently selected by dairymen because it enables them to handle themselves while milking. There are some closed stalls having iron piping for the partition walls, which, of course, is expensive, but reduces the amount of exposed surface. If one has to milk in the stall, he needs a roomy place and it is quite desirable that the milker should not rub up against other cows, or the cow which he milks or against the surface of the stall, or, in short, come in contact with anything that tends to create a disturbance in the atmosphere or stir up the dust.

The plan to follow, therefore, is to select a stall which has as little surface as is required for the separation of the animals, have the stall roomy and make it as convenient for the milker as possible. Again, if the cow can be removed from the stall, undoubtedly the best results will be obtained. Mr. Michels will illustrate some stalls found by experience the most satisfactory in the production of milk.

4. The Milker.—It is not possible to place too much stress upon the condition of the milker, for through his individuality may be found the answer for or against the production of pure and wholesome milk. If he is an individual who is naturally clean and tidy, the milk will accordingly be as good as can be produced under the conditions furnished; but if he is untidy and by nature filthy, the milk likewise will be found very dirty. The cleanliness of clothes and hands is a matter which the farmer occasionally abhors. He finds it sometimes troublesome to don a clean suit of clothes and wash his hands for the purpose of milking a few cows which supply his own table. Perhaps where so few cows are involved, the custom could be regarded as impracticable, especially if the aesthetic feeling is at a low ebb; but where dairying is looked upon as a business, and the milk and its products are sold to the public, considerations of cleanliness and care in the handling of milk cannot be despised or overlooked.

Dirt will manifest itself, and it is easily washed off from the hands into the milk by an occasional stream of milk impinging against their surface; or, it may fall from the clothes in a dry condition or be brushed off in one way or another and thus contaminate the milk. The hands of the man who works about the stable and fields are not, as a rule, fit to handle food, and he would not be expected to go into the kitchen and prepare a meal without washing his hands, nor could he be expected to come in close contact with food without changing his clothes, or, at least, donning an over-suit. If this is true, why should he be expected to milk cows and handle milk without being as cleanly as if he were preparing some appetizing food in the kitchen? Clean hands, clean clothes and clean habits are as essential to the production of good milk as they are to the housekeeper who prepares our meals; or as they are to society considered from an aesthetic standpoint.

There is another aspect of the milker which deserves careful review. He should be a sound man, free from any infectious disease, because it is an easy matter for a milker to transmit the germs from himself to the milk by means of his hands or his clothes or in various ways. Imagine a man suffering in the last stages of consumption handling the milk for sound individuals or that which is to be used for babes! Do what he will, he cannot free himself from

contamination with those germs which, if they once find their way into the milk, are capable of setting up disease. What is true of tuberculosis is also true of diphtheria, scarlet fever, and other diseases. These are facts, fully established, and the significance of which is well known.

Again, the milker should never come in contact with any one suffering from an infectious disease, for he may be the means of conveying the germs and thus cause a communicable disease to spread. Such instances are known, and it is easily understood how this may be the case. We conclude, therefore, that in order to have good, pure, wholesome milk, it is essential that the hands be washed; that a clean outer suit of denim, duck, or something similar, be donned; that freedom from disease exist, and that there be no communication with infectious diseases of any kind. The milker must observe these strictures upon his freedom, and should enter into their execution with zest if good results are to be obtained.

5. Milking Utensils.—Perhaps one of the most common sources of trouble, although it is not usually admitted, is the polluted condition of the utensils which are employed in the care of milk. Even in this civilized country, with its accumulation of knowledge, there are many milk producers who do not yet appreciate the fact that in order to have good milk it is essential to have clean utensils. From 500,000 to 50,000,000 of germs have been counted in each gram of dirt taken from the creases in a milk pail; while from its surface have been taken many thousand per square inch. This should never occur in a clean pail and one that is carefully cared for. Pure milk is impossible under such conditions.

It is not sufficient to wash out or rinse out a milk pail or any other milk utensil with warm or cold water and a cloth only; a brush is necessary, and it should be used with zeal and with a goodly amount of warm water at first; then it should be followed by a wash with a solution of sal-soda or lime water, or something akin, for the purpose of removing the fat. After this is done the utensil should be thoroughly rinsed with boiling water, then steamed, which will have a tendency to kill all micro-organisms present. Such treatment is the least to be done in cleaning milk utensils. If the milk producer does not believe in the thorough cleansing and its effectiveness, let him add milk from a sample lot, half of it to a dirty pail, and half of it to a properly cleansed pail, and watch the results. He will convince himself by this simple act.

A word might be said about the scientific significance of the sanitary milk pail so commonly mentioned at the present time. It is true that, if filthy conditions exist in the stable, also with the cow and milker, an open pail makes it possible to collect much dirt and filth; and that, if the opening were reduced in size, a certain amount of this filth would be eliminated. On the other hand, if the stable is clean and free from dust, the cow properly kept, the milker clean and tidy, and the pail sterile, the ordinary pail will give nearly as good practical results as the sanitary pail. If filthy conditions exist, it were better to milk through a pin-hole; but if proper conditions are established, one need not spend his energy in trying to strike the hole of the pail. Thus far, sanitary milk pails are not especially successful. This is true also of automatic milkers. Such things cannot overcome the real cause of the disorder. Usually these attempts amount to about the same as trying to cleanse the body by putting on a clean garment. The appearance may be a little better, but the results are not very satisfactory. If the pail is left open in a stable filled with dust, Marshall has estimated that as many as 3,600,000 germs may fall into that pail during the course of five minutes. In an ordinary room, free from dust, the number of germs would be comparatively insignificant.

6. Water Supply.—Water is a source of contamination too frequently overlooked. Some years ago an opportunity was offered for analyzing several samples of water, coming from dairies, creameries, and cheese factories. It was found that some of the samples furnished were veritable starters of an obnoxious character, such, in fact, as would produce bad results in milk and butter or cheese manufacture. Doubtless, therefore, if it were feasible to go through the country and ascertain the exact condition of the water supplies, the analyses would be more or less startling.

Typhoid fever epidemics have been traced to water employed in the washing and rinsing of dairy utensils. Other infections also have had such water supplies

for their source. Besides the direful effects of water in the conveyance of disease, there are the numerous serious fermentations which may be caused by the micro-organisms in the water supply. Traces of sewage, filth, or dirt, may be in the water, consequently the water may be as undesirable as the substances found in it.

VII. AERATION OF MILK.

The discussion concerning the aëration of milk is becoming a thing of the past. Practices are becoming quite uniform. Our readers are more or less familiar with the work of Special Bulletin No. 16, of this Station. We mean to quote a few paragraphs which will place before the reader some of the essential points concerning this phase of milk management.

"If agitation of milk therefore aids aëration and if during the few moments immediately after milking the interchange of gases between the air and milk is greatest, it follows that where milking is in process the air must be pure, otherwise the foulness of the air will be incorporated in the milk. Milk absorbs gases. What must be the condition of the air of a stable in which all sorts of fermentations are going on and in which are odors of diverse kinds? These obnoxious substances are in the air and must pass into the milk with the air.

"In addition to milking, frequently the milk is further agitated in the stable by passing it from pail to pail or even straining it and also sometimes aërating it. Such methods are rightly condemned and the reasons for such condemnation are conclusive. Milking and the handling of milk should be carried on in pure air. It is sometimes the practice of milk producers to pour milk directly from the milking pail into a ten gallon can. From the foregoing even this must be considered reprehensible, for filling the can excludes the oxygen, and, if the milk is not cooled, a temperature most suitable for the development of germ life is present—conditions, in short, which favor harmful fermentations. This is why there are recorded so many cases of poisoning as due to the improper care of the milk, eliminating the factor, filth, a common evil.

"It has long been known that animal odors and taints may be removed by aëration. Proper aëration will do it; however, aëration and cooling must not be confounded in this matter. Cooling apparently removes odors and taints, but such disappearances are due to the chilling of the milk, under which condition the milk gives up the volatile substances with reluctance, doubtless owing to the reduced power of volatility of the substances themselves when cold. When such odors and taints are removed by aëration the removal is permanent unless they are generated by bacteria which continue to grow after aëration. Odors and taints may be due to any one of the following causes.

1. Absorption of gases from the air by the milk.
2. Physiological processes of the cow.
3. Disease processes of the cow.
4. Bacterial growth in the milk.
5. Introduction of odoriferous substances into the milk.

"Odors in the air emanate from fermentations, foods, etc.; aromatic substances are likely to pass through the body and be secreted in the milk; a high temperature in an animal is likely to reveal itself in the milk; and frequently sufficient filth gets into the milk to give it a distinct flavor—all of these or any one of these causes may be the immediate producer of odor or taint.

"How aëration should be conducted is a matter of considerable importance, consequently we have added a few suggestions:

1. Aëration should be conducted at body temperature.
2. Aëration should be carried out over the most extensive surface possible and as slowly as possible.
3. Aëration should take place only in a pure atmosphere.
4. Aëration is best accomplished immediately after milking.
5. Aaeration should precede cooling.
6. Aëration and cooling simultaneously conducted cannot yield the most satisfactory results."

VIII. THE COOLING AND THE KEEPING COOL OF MILK.

No one factor will contribute so much to the welfare of the milk producer as a knowledge of cooling milk and its real significance, for in this process we

have the key to the management of either good or bad milk. Good milk will remain good indefinitely if kept sufficiently cold and bad milk will not grow worse if kept under the same conditions. Conn has done the most recent and most exhaustive work along this line. His table in Bulletin No. 26, of the Connecticut Experiment Station, illustrates this very graphically.

Number of bacteria per c. cm. in milk kept at different temperatures.

Number at outset.	In 12 hrs. at 50°.	In 12 hrs. at 50°.	In 50 hrs. at 50°	In 50 hours, or at time of curdling at 70°	No. hrs. to curdling at 50°	No. hrs. to curdling at 70°.
46,000	39,000	249,500	1,500,000	542,000,000	190	56
47,000	44,800	360,000	127,500	792,000,000, 36 hrs.	289	36
50,000	35,000	800,000	160,000	2,560,000,000, 42 hrs.	172	42

It is easily seen from the above how important it is that the milk be cooled, that it be cooled as soon after milking as feasible, and that it be kept cool until consumed or used for the manufacture of milk products.

Cold checks the development of micro-organisms. The freezing temperature is, of course, better than 40° F.; 40° F. is better than 50° F.; 50° F. is better than 60° F.; 60° F. is better than 70° F.; and 70° F. is better than 90° F. for retarding the growth of micro-organisms. It follows from this that milk should be cooled at as low a temperature as possible immediately after milking and be *kept cool.*

To accomplish the cooling of milk, any cold, extensive surface over which the milk may run will be satisfactory if in a clean room. Ice should be used if possible; if this is not available, employ running cold water. If coolers, such as the Starr or Champion, are not procurable, a tank of cold running water into which sets the can of milk, may be very advantageously substituted, but it is not so valuable. Under such conditions the milk should be stirred continuously until cool, otherwise an hour or two will be necessary for lowering the temperature of the milk to that of the water. Time should not be wasted in this manner, for the micro-organisms are usually very active at this stage.

IX. MILKING IN THE STABLE.

Little need be said concerning this subject because what has already been hinted at in the discussion of the dust and dirt of the stable will be applicable; and, further, the absorption of gases has been mentioned under aëration and will furnish pertinent material. These are matters which serve as our reason for condemning the common practice of allowing open pails and open cans of milk which are still warm to stand in the stable. Such practices are especially bad after feeding or bedding because at such times the amount of dust and dirt is materially increased. If 3,600,000 germs can fall into a milk pail during five minutes, we may ask how many will fall into a ten gallon can exposed in the stable while it is being filled by one milker?

Again, we have learned that milk absorbs gases. We know that constantly there are going off from fresh milk gases which are noticeable to our olfactory nerves. It must not be supposed that these gases pass off without others of the stable taking their place. It is an interchange of gases rather than a simple elimination of the cowy odors in the milk. Therefore, either from the standpoint of eliminating the germs, or from the standpoint of absorbing obnoxious gases from the stable, the practice of exposing milk in the stable is reprehensible.

X. STRAINING OF MILK.

Too much energy is expended upon the straining of milk. Does it seem rational to the milk producer that it is possible for him to intercept germs which are one ten-thousandth or one twenty-five thousandth of an inch in length by a copper sieve with a one-sixteenth or a one-fortieth inch mesh; or by cheese-cloth, with its loose texture, even when used in folds four thick; or even by placing layers of cotton over the sieve? One might pertinently ask the question, "Is it possible

to catch fish with a net whose meshes are large enough to allow a whole school of fish to pass through at once, or even intercept them by filling the stream with brush?" This is what is attempted with strainers of copper, cloth or cotton wool. What dirt is soluble will pass through, and it is true that what is insoluble will remain upon the filter, usually. Yet all the dirt which may be found upon a hair that has been arrested by the filter, has been washed off and through by the impinging streams. In other words, dirt which is insoluble or particles of hair, straw, hay, etc., which will not pass through the sieve or strainer are thoroughly washed upon the sieve by the impinging stream of milk, and the result is that all the dirt goes into the milk and these substances are left clean upon the sieve.

Conn, in his exhaustive work upon straining has shown by actual count that the number of germs in milk strained or unstrained is practically the same. It is fair to consider that straining removes what is visible to the eye, and one feels some satisfaction in not having particles of dirt, straw, and things of this nature passing down his throat while drinking milk. He does not think further and consider whether the objectionable features are in the milk or not.

XI. SANITATION OF THE STABLE AND DAIRY.

This old subject may not be so well defined as many newer ones, yet it cannot be passed over without giving it due consideration. It is important because several factors are involved, which, although not immediately perceptible, have a marked bearing upon some dairy practices.

Light should be admitted to the stable in abundance because it causes physiological vigor of the animals, checks fermentation and induces cleanly habits. This action of light is likewise useful in the dairy, for direct sunlight upon dairy utensils and the dairy room is as good as the best disinfectants.

Ventilation is necessary for perfect respiration of the animal, for the exchange of the gas laden atmosphere of the stable with the pure air from without, that the animal may profit thereby and that absorption of obnoxious gases by milk may be eliminated.

Drainage is essential to reduce the amount of fermentation to the minimum, as well as to enable cleanliness and health to be maintained, for it is in the accumulated filth of the stable that fermentation is possible, consequently unsavory odors, gases and unsightly conditions.

OUTLINE FOR MILK MANAGEMENT.

1. The cow should be sound,—no disease should exist in the animal.
2. The feed should be good and free from aromatic substances. If these aromatic foods are used they should be employed according to those methods which will not cause odors or flavors to appear in the milk.
3. The cow should be groomed and hair about the udder preferably clipped.
4. The udder should be moistened during milking.
5. The milker should be a neat tidy person.
6. The milker should be free from disease and should not come in contact with any communicable disease.
7. The milker's hands and clothes should be clean while milking.
8. The pail should be sterilized.
9. The stall should be such as to reduce the amount of disturbance of dust and dirt.
10. There should be good light, good ventilation and good drainage in the stable.
11. The stable should always be kept clean.
12. Feeding and bedding, unless moist, should be done after milking.
13. A dustless milking room is desirable.
14. Milk should not stand in the stable.
15. If milk is aërated, it should be done before cooling and in pure air.
16. The sooner the milk is cooled after milking, the better.
17. Keep the milk as cold as possible when once cooled.

Laboratory of Bacteriology and Hygiene.
August 8, 1904.

PART II.

PRACTICAL CONDITIONS FOR THE PRODUCTION OF MILK.

JOHN MICHELS.

There is nothing of an original nature claimed for this bulletin, neither is it considered to be an exhaustive treatise of the subject under discussion, its aim being merely to throw out a few suggestions as they appeal to the practical dairyman. It is pertinent to the discussion to add that some of the phases of the subject as treated herein have been previously considered by Director C. D. Smith, not in bulletin form, but in the 1895 Report of the Board of Agriculture, which is now out of print. The increasing attention that milk production is receiving makes it exceedingly desirable that practical hints and cautions be sent out from time to time, regarding the economic production of pure milk, and this bulletin is submitted with this in view and in response to a demand that has of late become quite urgent.

In view of a persistent demand at present for the production of cleaner and purer milk, it has been deemed desirable to present in this bulletin some practical methods of securing it upon the average farm, in other words, under ordinary conditions. To aid in making the discussion of this subject as practicable as possible, the writer has visited the farms of several of the leading dairymen of the State, and has made a careful study of the methods in vogue. It is not proposed here to enter into a discussion of the methods employed in each of these dairies, for too much space would be required to set forth all that may be said to advantage, but it has been the purpose throughout to draw from each those lessons which may furnish to milk producers hints for their own practices, and to recommend those methods which are found to be employed by the best dairymen. That the material secured might be systematically arranged, we have endeavored to divide it as follows:

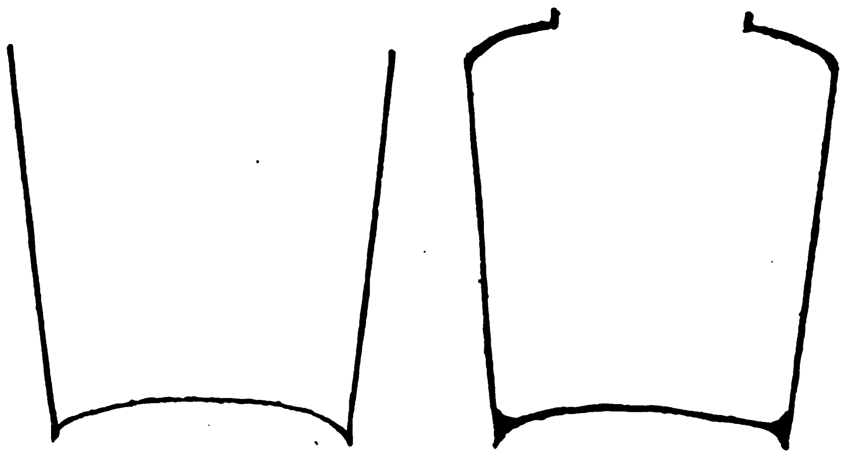
I. Utensils Used in the Dairy.
II. The Wash-Room.
III. The Stable.
IV. The Barn-Yard.
V. The Cow.
VI. The Milker.
VII. The Care of the Milk after It Has Been Drawn.

I. UTENSILS USED IN THE DAIRY.

All utensils used in the handling of milk should be made of good tin, with as few seams as possible. Wherever seams occur, they should be flushed with solder. Unflushed seams afford excellent breeding places for micro-organisms, and are doubtless the source of much trouble in the dairy. Figure I illustrates the character of the unflushed seam.

Figure II represents a flushed seam, which fully illustrates its value. This figure also represents a sanitary milk pail, with a partly closed top. It is modeled after that used by Gurler. The sanitary milk pail is further represented in Figure III, where it can easily be seen with its spout, which permits ready emptying, and it will also be noticed that it is covered with a cap during the process of milking. The cap is shown at the right. The ring at the left fastens the strainer, which should consist of a double layer of cheese cloth enclosing a layer of absorbent cotton. The purpose of the cotton is to retain fine hairs and any particles of dirt that are not dissolved by the milk. It should be renewed at each milking. The value of a partially closed pail is evidenced by the reduced surface, which has a tendency to keep out many of the microorganisms, which would otherwise drop into the pail during milking. To illustrate, a half closed top would have the effect of reducing the contamination from this source about fifty per cent.

It is well to say in this connection that there are many objections to the so-called sanitary milk pail. It without doubt reduces the contaminaion when the



FIGS. I AND II.

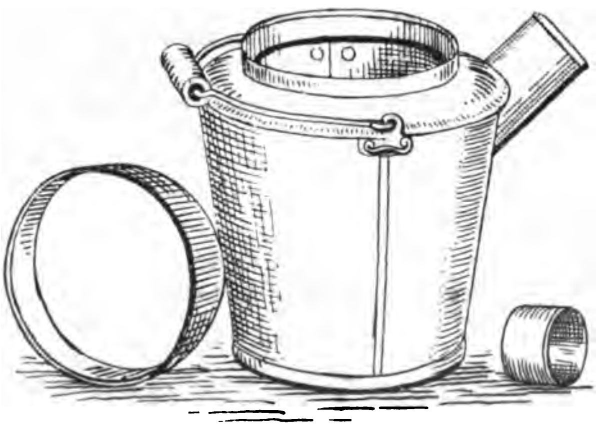


FIG. III.

contamination occurs, but when cleanliness is rigorously practiced, no doubt the disadvantages exceed the benefits. (See Part I, page 173.) However, many of our best dairymen use it continually.

II. THE WASH ROOM.

A room for the purpose of washing the dairy utensils is a very important part of the equipment. It should be provided with shelves, some good washing substance, as sal soda, hot and cold water, and, if possible, steam. The shelves should be placed near a large window where the tin-ware is exposed to the disinfecting action of the sunlight. The cleaning of dairy utensils is best conducted as follows.

First, rinse with warm, or perhaps preferably cold water—never use boiling or hot water at first or the milk will become cemented to the utensil. Second, scrub with moderately hot water containing some sal soda. The washing should be done with brushes rather than cloth because the bristles enter into any crevices

present which the cloth cannot possibly reach. Furthermore, it is very difficult to keep the cloth clean. Third, scald thoroughly with steam or hot water, after rinsing out the water in which the sal soda was used. After scalding, the utensils should be inverted on the shelves without wiping and allowed to remain in this place until ready to use. This will leave the vessels in a practically sterile condition. Fourth, if it is possible to turn the inside of the vessels to the sun, in a place where there is no dust, then it is desirable to expose the utensils during the day to the strong germicidal action of the direct sun's rays.

In washing strainers, or cloth used for straining, care should be exercised in placing these in boiling water a few minutes after thorough cleaning. From the boiling water they are spread out to dry in a clean and dustless place.

III. THE STABLE.

Light, ventilation and ease of cleaning are essential to a sanitary stable. In order to secure light, underground stables must be avoided, and, when the stables are above ground, a sufficient number of windows should be inserted. Remember that there is vigor of physiological growth and reduced decomposition by the introduction of sufficient light. Good ventilation is not secured unless better facilities are offered than the occasional admittance of air through doors and windows. This is especially true in the winter season. A continuous ventilating system, such as has been devised by Prof. King,* may be recommended with much confidence, because it has been successfully employed in many of the leading dairy barns of the country. This system may be briefly described as consisting of air shafts in the outer wall, which admit fresh air. An opening near the floor carries it up to a point near the ceiling, where it is discharged into the barn. Impure air is removed by flues opening near the stable floor, and extending through the roof of the barn.

That easy and thorough cleaning of floors may be assured, it is desireable that the mangers and gutters be built of concrete. The floor of a truly sanitary stable must not only be daily freed from manure, but must also receive a daily scrubbing. The walls and ceiling should be kept free from dust and cobwebs and should be whitewashed at least once each month. Lime is a good absorbent of odors, and may be advantageously employed in the gutters. It checks fermentation, also.

Should any fermented foods, decomposed substances, or highly aromatic foods be left about the barn, or stable, the odors or aromas arising from such materials are likely to be absorbed by the milk. The surroundings of the barn should be kept perfectly clean, for cleanliness means pure air, better stables and clean milk.

The stalls of a stable are a very important item. They should be built for the purpose of keeping the cow clean, of protecting her, and of giving her as much comfort as possible. It is also desirable that the stall be of such a nature as not to cause any disturbance to the milker or produce dust by his movements. That the cow may be kept clean, her position in the stall should place her hind feet on the edge of the gutter. In order to have comfort, she should not be confined in a rigid stanchion. These purposes may be accomplished by a stall closed in the rear with a chain, as shown in Figures IV and V, or tied in a half stall, after the fashion shown in Figure VI.

Figure IV illustrates an iron stall, in which the cow is not tied in any manner, but held in position by means of a chain in the rear. This is known as the Drown stall. While possessing all that is desirable in an ideal stall, its cost, which is about $9.00, makes it quite impracticable upon many farms. The wood stall of similar construction, by the same patentee, costs less than half this amount. The patentee receives a royalty of fifty cents. It should also be mentioned that the gates shown in the illustration may be raised up as well as moved out.

Figure V shows a stall quite similar to this excepting the wood which is used in its structure. This is known as the Bidwell stall. The manger is movable, and the stall may be adjusted to suit small as well as large cows. This stall, including a fifty cent royalty, should not cost above $3.50.

Both of the above stalls are comfortable, and will keep cows clean. The cows stand close to the gutter, but, owing to the chain in the rear, cannot step into

* See "Physics of Agriculture," pages 355-357, by Prof. F. H. King, Madison, Wis.

FIG. IV.

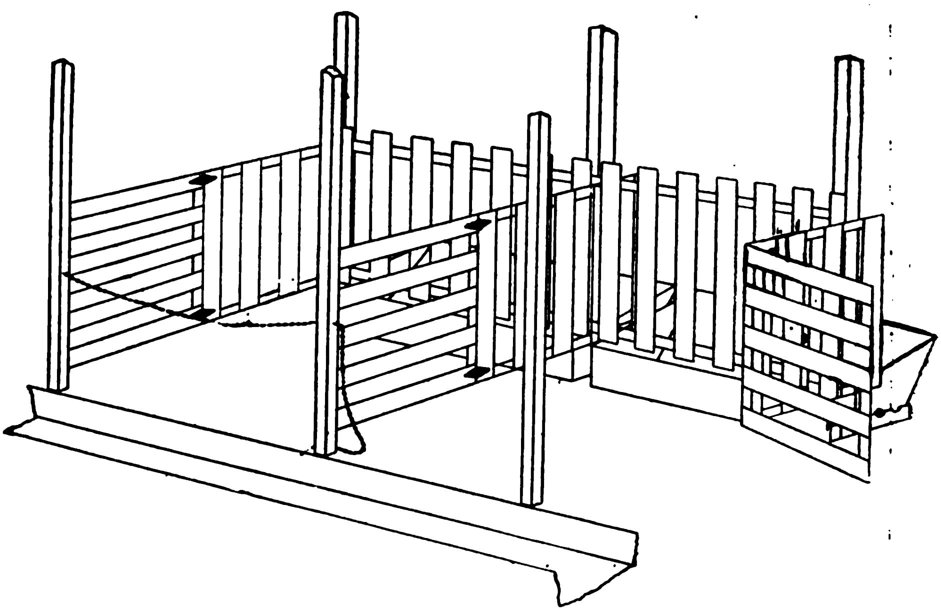


FIG. V.

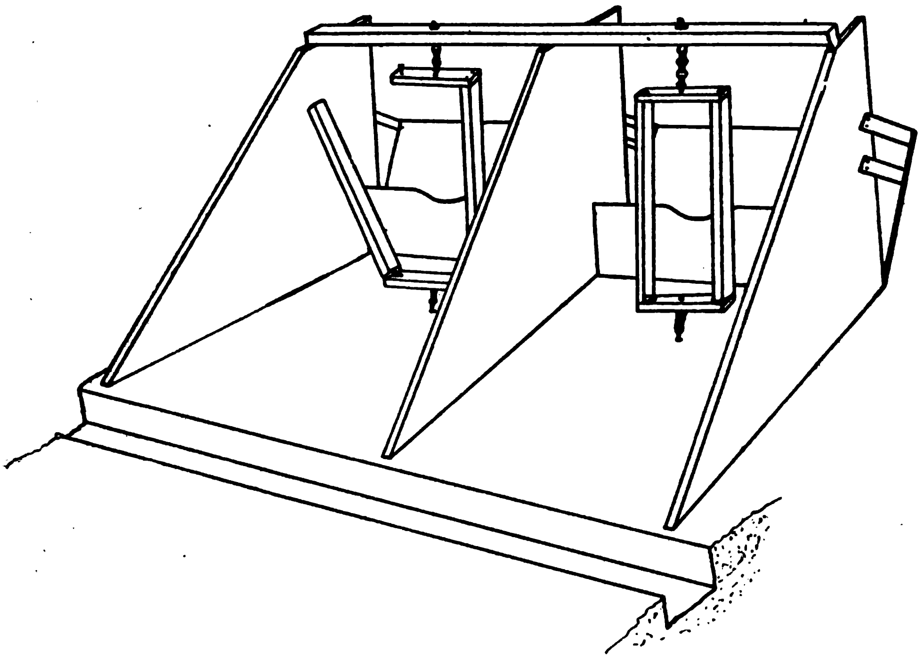


FIG. VI.

it. It should be stated, in this connection, that where the partition is complete between the cows, there is a serious objection arising because the milker entering a stall of this nature, may cause more or less dirt to fall into the pail, or will cause dust to rise which will get into the milk during milking. A precaution necessary in constructing these stalls is to have the posts as close to the edge of the gutter as possible.

Figure VI shows a half stall which has been endorsed by many leading dairymen. With this stall, however, cows will occasionally step back into the gutter, especially when tied in front with chain or rope.

There is also a possibility of the cows treading on each other and doing injury in these stalls, as well as when the stanchions alone are used without the presence of any partition.

IV. THE BARNYARD.

A clean, well-drained barnyard is an essential factor in the production of sanitary milk, for where cows are obliged to wade in mire and filth, it is easy to foretell what the quality of the milk will be. In order to secure a good barnyard, the slope should be away from the stable, or at least not towards the stable, and it should be covered with gravel or cinders. If the manure is not taken directly from the stables to the fields, it should be placed where the cows cannot have access to it.

V. THE COW.

Ordinarily, when milking, a great number of bacteria will find their way into the milk through the dust and dirt and hairs which fall from the cow. This may be largely prevented by wiping the flanks and udder with a moist sponge or cloth just before milking. It is still better to wash; however, this procedure

requires more time, as it must be followed by careful wiping to prevent dripping. Cows should not be bedded, fed, or carded, just before milking, as any one of these acts creates dust which will certainly find its way into the milk. If pure milk is sought, it is desirable to reject the first streams of milk from each teat, as these contain thousands of bacteria. The reason for this rich development of germs is found in the favorable conditions provided by the milk in the milk-cistern of the udder, and also by the possible access of the germs through the milk-duct.

VI. THE MILKER.

Clothes which have been worn in the fields during the day are not suitable for milking purposes. Every milker should be provided with a clean, white

milking suit, like that illustrated in Figure VII. Such clothes can be bought ready-made for less than a dollar; and, if frequently washed, will aid in securing clean milk. Milkers should also wash and dry their hands before milking, and, above all, should keep them dry during milking. To wet the hands with the milk is a filthy practice.

VII. THE CARE OF THE MILK AFTER IT IS DRAWN.

Immediately after milking, the milk should be removed from the barn to a clean, pure atmosphere, where it is aërated and cooled by running it over a combined aërator and cooler of the type shown in Figures VIII and IX. If it is possible to aërate the milk while warm, should aëration be desired, better results will be obtained than where aëration and cooling are attempted in the same process and at the same time. The barrel shown in Figure VIII is filled with cold water, which circulates between the two tinned surfaces of the cooler, over-

which the milk flows in thin sheets. By this means it is possible to reduce the temperature of the milk at least to within five degrees of the temperature of the water used for cooling. The cooler shown in Figure IX allows cold water to enter at the bottom and the warm water to overflow at the top, while the milk flows in a thin sheet over the outside of the cooler. If ice is at hand, it is desirable to use it in both cooling apparatus.

Always keep aërators and coolers as clean as any other dairy utensils.

FIG. VIII.

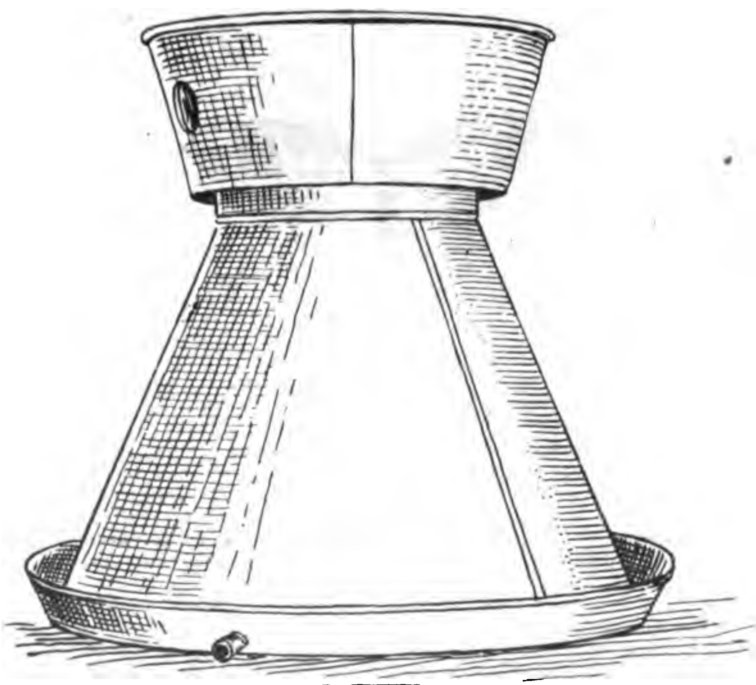


FIG. IX.

THE CODLING-MOTH IN MICHIGAN.

R. H. PETTIT, ENTOMOLOGIST.

Bulletin No. 222.

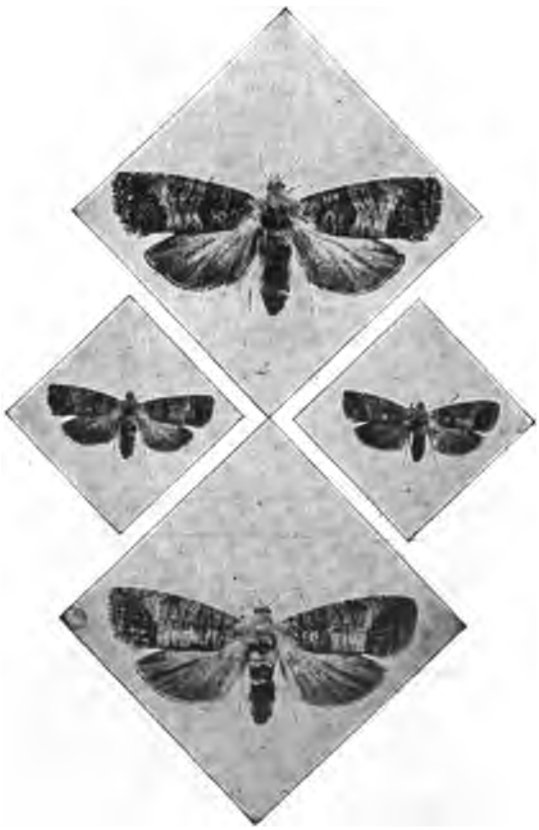


Fig. 1.—Codling-moths, the upper and lower ones enlarged. From Slingerland, Cornell University Experiment Station.

While the present bulletin will be found to contain very little that has not been worked over before, it is based on observations made in Michigan. Very careful studies have been made by Professor M. V. Slingerland of Cornell University, by Professor J. M. Aldrich of the Idaho Agricultural College, by Professor Fred W. Card, formerly of Nebraska, and more recently, by Mr. C. B. Simpson of the Department of Agriculture, who has published an extensive and exhaustive monograph on the subject.

The field work has been done almost entirely by student assistants, Mr. H. F. Tuttle during the summer of 1903, and by Mr. V. R. Gardner in 1904. Their careful and painstaking labor has made it possible to carry on the work.

The present activity in horticultural circles and the recent work of Simpson, Slingerland, Aldrich, Card and others, has brought the question of the control

of the codling-moth very forcibly to our notice. Furthermore, in making recommendations for the treatment of trees, it became apparent that many points in the life-history of the creature were only to be guessed at in this, the most northerly State of the middle United States, where the pest is common. It is so important indeed that the depredations of all other apple insects sink into insignificance when compared with it,—so serious that half or more of the apple crop is sacrificed annually to its inroads. Furthermore, conditons vary so widely in the great apple growing regions of our country, that data collected in different localities and in different latitudes, might be so widely at variance that they would be of little value except in the immediate regions where they were obtained.

Early in the spring of 1903, it was decided to start a series of observations which should, if possible, give us reliable information on the number of broods, the times when they occur, and the effects of a spray applied just when the second brood of larvae were ready to enter the fruit. These observations have been carried on over a space of two seasons, and the following results obtained:

In order to understand clearly the sequence of the broods, it will be necessary to review briefly the life-history of the creature.

The winter is passed in the larval condition enclosed in a cocoon of white silk, in which is bound considerable frass or chewed up fibre. This winter cocoon is quite thick and heavy and ordinarily is to be found neatly hidden away under loose pieces of bark, beneath fence-rails, under branches and in similar places. Often the cocoon possesses only a very thin film of silk next the wood and the bark, most of the material being used in making a ring between these two surfaces. The cocoon is about half an inch long and oval in form, just occupying the space allowed. Often, a tube extends from the outer more roomy part under the flake, down to the thin part of the wedge-shaped opening where the cocoon is placed, the larva in such a case, having commenced to spin where the space was too large, had crowded in toward the narrower part as it built.

Diligent search was made for these cocoons, in the spring of 1903, and two in good condition were found. A quantity of empty ones came to light, the larvae having been picked out by birds during the winter. These two cocoons were placed in cages and while their transformations may have been somewhat hastened by reason of being brought into the house, there is reason to believe that adults out of doors emerged soon afterwards. The two emerged on May 22. On June 12, I found eggs and young larvae. It may be well to state that on May 25, the blooms on the trees had practically all fallen, for on that date the spraying of the College orchard commenced.

The codling-moth, as everyone knows, has very poorly defined broods, the members of a single generation becoming adults over a considerable range of time, and not emerging all together as in the case of the canker-worm and many other insects. The most that could be hoped for would be to ascertain the top of the wave of prevalence of the insect in each stage, thus it is very desirable to know just when the greatest number of the eggs hatch, when the spinning of the cocoons is most actively carried on, etc., and these things for each generation. With these facts at hand, it is much easier to so time the application of the sprays as to catch the greatest number of young larvae just entering the fruit.

Simpson, in his bulletin number 41, of the Division of Entomology, gives fifty-five to fifty-eight days as the average time required for the moth to complete its life cycle, and counting backward from June 12, the time when the eggs and young larvae predominated, we find that our two moths probably emerged before the majority of those out of doors. We have set June 1 as about the right time. Counting ahead 57 days, we get the date of the emergence of the adults of the second generation on about July 27, and in our cages containing freshly collected cocoons, we get the greatest number of adults at this time.

A schedule made up partially from our observations in 1903, and partly from calculations, using fifty-seven days as an average time for the completion of the life cycle, would look something like this:—

FIRST GENERATION.

First adults, May 22 (blooms falling about May 25).
Most adults, June 1.
Most eggs, June 9.

Most eggs and young larvae, June 12.
Most larvae, June 15.
Most spun up in cocoons, July 12.

SECOND GENERATION.

Most adults, July 27 (shown in cages from fresh cocoons).
Most eggs, August 6. (Spray at this time.)
Most larvae, August 11. (Young larvae shown in orchard.)
Most cocoons just spun up, September 2.

POSSIBLE THIRD GENERATION, FROM COMPUTATION, AND NOT FROM OBSERVATION.

Most adults, September 23, (due at this time).
Most eggs, October 1, (due at this time).
Most larvae, October 6 (due at this time).

In his work on the codling-moth, Mr. Simpson refers constantly to the bands placed about the trunks of trees for the purpose of providing suitable places for the larvae to pupate. By the use of these bands, he was able to get reliable and indisputable data on the time of pupation at least. By daily counts he readily determined the exact times when the larvae went in as well as when the adults came out. We tried these bands made of burlap, but with very indifferent success in 1903, over half of the larvae not caring to utilize them but preferring

Fig. 2.—Codling-moths. From Slingerland.

for the most part, to pupate under loose flakes of bark instead. For this reason, we were obliged to substitute some other plans for keeping counts. The orchard which we used was a large one, and one that contained trees of all ages, so we determined to spend about the same amount of time and labor each day in searching for the larvae which were just spinning up in cocoons, and for the eggs and young larvae on or in the fruit. This plan would seem at first to be very crude and to promise little in the way of accuracy, but when we consider further that each count is double in character, and that cocoons are compared each day with larvae, and that eggs are compared with young larvae, that the emergence of the adults is checked by cage experiments, we will find that while the method may be inferior to that of banding, it does readily give us useful facts and with a fair degree of accuracy. Our bands failed because the flakes of bark offered more desirable quarters. During 1904, we selected ten trees in an old orchard which was not to be sprayed, and scraped off all flakes and scales, thus driving most of the larvae under the bands. We also obtained more accurate information relating to the time of the first appearance of the adults in the spring.

In order to collect evidence relative to a possible third brood, two trees, unsprayed except for the first spraying, in the College orchard, were carefully gone over and all wormy fruit removed on September 18 and 19, just before the adults of the third brood might be expected, if at all; a glance at the schedule

will show September 23 as the estimated date for the adults of the third brood. On October 17 and 24, the apples were picked from one of these trees and each examined for larvae. Many tiny larvae were present as well as a number of quarter grown ones of various sizes ranging between. It was therefore impossible to determine in this way, whether the larvae found, were the offspring of belated moths of the second generation or members of the third generation. We know that there is a wide range of time over which the adults come out and it is not at all impossible that these larvae were the late arrivals of the second generation which were getting ready to pass the winter in the barrels after picking. An examination of the wormy apples picked on September 19 showed that out of 800 larvae, 150 entered at the calyx, and about 650 elsewhere, or a little under 19% at the calyx or blossom end, as against 26.1% obtained by Simpson from a more extended series of counts, for the second brood. Our counts for 1904 give a very different result.

When the point of entrance is other than at the calyx, the commencement of the tunnel is often where two apples touch or where an apple and a leaf touch. In our cages, the eggs were laid indiscriminately on glass, foliage and some on fruit, the moth seeming to greatly prefer glass.

The experience of 1903, led to a modification of the plans in 1904. The use of ten trees in an old, unsprayed, but bearing orchard was obtained, and these trees were carefully scraped, all the loose bark being removed with a steel scraper while moist, and bands of burlap were loosely fastened, one or two about the trunk of each tree. These were utilized by the larvae for shelters under which to spin cocoons. Under these conditions, it was easy to find with precision, the dates when the larvae spun up, and by collecting the cocoons, and placing them in cages, it was easy to find just when the adults emerged. Counts were made from time to time,—every one, two or three days, and each time a count was made, the total number of cocoons found was divided by the number of days intervening between that count and the one immediately preceding, so that a very good average was obtained.

The season of 1904 was at least ten days late. Furthermore, at the time of the first spraying, the weather was wet and the stamens were slow in drying and curling up, remaining instead and filling up the calyx so that poison could not penetrate. Everything was delayed throughout the season, so that dates obtained this year may with safety be put back about a week.

The calendar for the codling-moth for this season would look something like this.—

FIRST GENERATION (1904.)

Pupation most active, May 16, (about half larvae and half pupae),
Sprayed, June 3. (Petals falling or fallen.)
First adult, June 4.
Most adults, June 10-12.
First larvae entering apples, June 22.
Most larvae entering apples, July 5.
First cocoons, July 11.
Most cocoons, July 20.

SECOND GENERATION.

First adult, July 30.
Most adults, August 5 (in cages).
First eggs, August 3.
Sprayed trees, August 9.
Most eggs, August 26 (well marked).
Larvae entering in large numbers, August 26 to September 7
Most cocoons, September 28-30.

This table has been compiled from a mass of data collected in various ways from the field and laboratory, breeding-cages, etc., and there is reason to believe that it will not come far amiss for 1904, in our State. Of course each brood extends over a long period of time and the broods overlap very badly.

Following is a table giving the results of the examination of bands for the season. It gives the number of larvae that enter the bands each day for the purpose of spinning cocoons. Each cocoon as soon as found, was, of course, removed or destroyed.

From July 13 to August 5, hogs were in the orchard, also from September 6 to October 7. Considerable brush lay on the ground under the trees from early pruning time until about September 6 when it was removed.

BAND RECORD FOR 1904.

Date.		Number of cocoons.	Average number daily.
July	11	2	2
	13	5	2½
	15	16	8
	16	5	5
	18	19	9½
	19	11	11
	20	24	24
	21	19	19
	22	18	18
	23	20	20
	25	30	15
	26	16	16
	27	18	18
	28	10	10
	29	7	7
	30	13	13
Aug.	1	11	5½
	2	8	8
	3	2	2
	4	6	6
	5	3	3
	8	13	4⅓
	10	4	2
	11	2	2
	12	3	3
	13	3	3
	15	5	2½
	16	1	1
	18	2	1
	20	1	½
	23	7	2⅓
	26	6	2
	29	6	2
	31	0	0
Sept.	3	3	1
	6	2	⅔
	8	1	½
	10	3	1½
	12	3	1½
	14	7	3½
	16	8	4
	17	4	4
	19	30	15
	21	13	6½
	22	0	0
	26	44	11
	28	39	19½
	30	47	23½
Oct.	1	13	13
	3	19	9½
	6	19	6⅓
	8	15	7½
	12	80	20
	18	50	8⅓
	21	52	17⅓
	26	6	1
	29	6	2
Nov.	2	10	2½
	8	14	2⅓

In order to get an estimate as to the times when the larvae entered the apples in greatest numbers, examinations of the fruit were made at short intervals. Fifty apples were picked at random from an unsprayed tree at each examination, and these were cut open to make sure whether they contained larvae or not. The variation is accounted for when we consider that the apples were picked from various parts of the tree.

Following is the result of these counts for 1904:—

NUMBER OF LARVAE ENTERING APPLES, 1904.

Date.	Number found.	Just entering.
June 10	0	
20	0	
22	2	
24	6	
27	7	
30	8	
July 2	12	
5	8	
6	17	
8	14	
9	18	
11	17	
13	21	
15	20	
18	21	
20	18	4
25	12	2
27	21	4
29	22	8
30	13	5
Aug. 1	13	3
3	21	3
10	11	7
11	18	5
13	21	6
15	22	10
16	19	9
20	20	15
26	30	20
29	30	14
31	27	7
Sept. 3	30	10
6	37	8
8	37	9
10	19	6
12	26	3
14	23	1
16	24	1
17	26	1
19	27	0
21	28	4
22	35	1
28	33	4
30	29	0
Oct. 1	27	2
6	31	0
18	24	1
21	36	0

On September 10 a change was made in the tree from which the counts were made, it being impossible to obtain more apples from the original tree used (a Shiawassee). The rest of the counts were made from a russet in the orchard where the bands were placed.

Toward the latter end of the season, great numbers of the wormy apples fell, thus reducing the count very materially. The tree being a russet. This accounts for the apparent discrepancy between this count and the count from the entire trees, which latter was made from spies.

THE PLACE OF ENTRY.

During the season of 1903, a large proportion of the whole number of larvae entered at the calyx or blossom end of the fruit in the first brood, and 19% was the proportion of the second brood entering at the calyx, as based on a count of 800 larvae made on September 19, 1903. Strangely enough, in 1904, a similar count for the first brood, made from 450 apples, gave 28 from the side and 64 from the blossom end or about 30% from the side. On the other hand, a count of 1,000 apples, taken on August 31 and afterward, gave 235 from the side and 440 from the blossom end, or nearly 35% from the side. These counts were, of course, made on a small number of apples, but at the same time, they are suggestive.

THE EGG.

Description—The egg is flat and scale-like, being less than 1-16 of an inch in diameter. It is first, pearly, later becoming yellowish. It requires at all times close observation to find it.

In order to make the calendar of the moth more complete, a short series of observations were made on the times of greatest activity in egg laying. In interpreting the counts given it should be remembered that some of the eggs were probably hatched. Then, too, those found very late in the season may have been laid some time before, the cool weather preventing them from hatching at all. The following table gives also some comparison as to the relative number laid on the fruit and on the leaves. The number of leaves and apples examined, was fifty each on each date, except August 3, when 100 leaves were examined.

THE EGG LAYING OF THE SECOND BROOD, 1904.

Date.	No. of eggs found on fruit.	No. of eggs found on leaves.
Aug. 3.	3	1
4	..	2
10	..	6
11	12	7
12	..	7
13	9	2
15	22	4
16	16	4
20	20	
23	..	9
26	38	13
27	..	1
29	29	4
31	19	8
Sept. 3	22	3
6	30	5
8	16	
10	10	2
12	5	1
14	7	
16	12	1
17	5	1
19	9	1
21	6	0
22	6	8
28	13	0
30	9	0
Oct. 1	8	4
6	7	3
18	5	2

A comparison between these figures shows that in an equal number of fruits and leaves, viz., 1,150 each, nearly 19% of the eggs were laid on the leaves.

In order to get an idea of the proportion of eggs that were laid on the foliage as a whole as compared with the number laid on the fruit, a count was made of the leaves and fruits on a part of a good bearing tree in the College orchard. On September 15, 1904, a limb 3⅛ inches in diameter, which had been split from the tree by the wind, was removed from the tree and each leaf and apple picked off and counted at the time. The result was as follows,—986 apples and 26,395 leaves, or 26.8 times as many leaves as apples. A count of 1,150 leaves and 1,150 apples, gave us 69 eggs laid on the leaves and 295 eggs laid on apples. This gives us 13.76% of the eggs laid on the fruit as against 86.24% on the foliage. Furthermore, the young larvae were found to feed on the underside of the leaves, removing small patches of the soft tissue. This helps to explain why the August spray is so efficient, for it is much easier to make the spray cover and stick to a leaf, than to an apple.

EXPERIMENT IN SPRAYING FOR THE CODLING-MOTH.

In order to put to a practical test, the effect of two sprays, applied as indicated by the calendar, permission was obtained to spray an orchard of about forty trees, in the vicinity of the College. Accordingly a spray of paris-green and bordeaux was applied, using four pounds of copper sulphate, six pounds of lime and 40 gallons of water, to which was added four ounces of paris-green. This was carefully put on on June 3, 1904. A second spray was applied on August 9, using four ounces of paris-green and eight ounces of lime to 40 gallons of water. Examinations of 60 apples made on July 13 showed three larvae or 5%; there were evidence of more which had entered into the calyx, but had died there. Another examination on August 31 showed three live larvae with three more that had died in trying to gain entrance.

On October 15, 1904, three trees were picked and the fruit sorted as carefully as possible without cutting open each apple. One tree (No. III) was unsprayed because of its location, being difficult to get at. This tree was the best one of a group of four unsprayed trees standing near together. It had borne well and would have produced a fine lot of fruit had it received the same treatment as the others. The fruit was, however, scabby, and a large number of wormy apples had fallen. The variety of trees I to V was Northern Spy. A count from this tree gave the following result:

TREE III. UNSPRAYED, IN SPRAYED ORCHARD.

Yield	12 bu.
No. of apples	1,560
Not wormy	897
Wormy	663
Per cent wormy	42.5

The reason for the vastly superior yield of this tree over that of trees IV and V, in the unsprayed orchard is easy to see. The sprayed orchard was better pruned, cultivated, and fertilized, and the percentage of sound fruits was raised because great numbers of the moths from this tree spread themselves over the rest of the orchard, while few moths from other trees came to this one. The difference in the yield was largely due to culture, but the difference in the percentage of wormy fruit was largely due to the fact that the surrounding trees were well sprayed.

Two other trees that had been sprayed twice, as previously described, were examined on the same day. Tree I was considerably further away from tree III than tree II. An examination of tree II gave the following results. There was little scab.

TREE II.—SPRAYED TWICE.

Yield	13 bu.
No. of apples	1,706
Not wormy	1,483
Wormy	223
Per cent wormy	13.07

Tree I gave the following results. It was in the same orchard but more distant from tree III than tree II. There was little scab.

TREE I.—SPRAYED.

Yield	12 bu.
No. of apples	1,883
Not wormy	1,750
Wormy	133
Per cent wormy	7.06

This shows great superiority in salable fruit in the case of the sprayed orchard.

Counts made from two trees in an unsprayed orchard, the one in which we had banded trees, were made on October 8. Two Northern Spy trees were selected, as this was the only variety common to both orchards, which had trees of approximately the same size, and also because the Spy is standard in Michigan. The outputs of these two trees were classed together, being rather light. The result was as follows:

TREES IV AND V.—UNSPRAYED, IN UNSPRAYED ORCHARDS.

Yield	7½ bu.
No. of apples	1,054
Not wormy	114
Wormy	940
Per cent wormy	89.3

There was much scab on the fruit and many windfalls. This helped to pull down the yield very appreciably. The fruit in no case was cut open, but judged as well as possible from outside appearances.

THE THIRD BROOD.

The work of the present season seems to indicate two annual generations rather than three. It was at first thought that the presence of young larvae in the apples in October, which had appeared just when the third brood would have been due, was very suggestive of a third brood, but the counts made in 1904, showing the waves of pupation, etc., do not bear out this theory. If there were a third brood, one would expect to find a corresponding wave of pupae and adults, furthermore, in our observations, the October larvae were not of a uniform size, grading instead from very small individuals to those of considerable size. The fact remains, however, that larvae *do* enter the fruit late in the season, working in considerable numbers even after the apples have been packed and sold.

NATURAL ENEMIES.

Besides a number of parasites which infest the codling-moth, we find here a fungus disease (*Isaria farinosa*) which was separated out and grown in pure culture by the writer during the season of 1903, and which fungus killed other larvae that were brought in contact with the culture. An attempt to collect winter cocoons called attention to the fact that birds play an important part in keeping down the insect. Most of the cocoons found in the spring were concealed beneath flakes of loose bark, and in almost every case, a hole through the bark flake to the inside of the cocoon, showed an opening through which the larvae had been extracted.

Such pierced cocoons are the common thing in our orchards, especially is this true in all cases where they have been placed high enough to be above the snow line. Those placed below the level of the snow are more or less protected and are more likely to escape. For this reason it will be good practice to scrape off in the fall all loose flakes below the level of the snow.

Some parasitic hymenoptera were bred from cocoons collected from under the bands.

Large numbers that winter under fences, brush, etc., are doubtless eaten by shrews, which are quite plentiful in Michigan orchards.

Fig. 3.—Inner surface of a flake of bark, showing cocoon of codling-moth, enlarged, and the hole pierced by woodpecker in extracting the larvæ.

FUMIGATION OF STORAGE HOUSES.

Great numbers pass the winter in storage houses, in cellars where apples are stored, in old barrels, etc. Fumigation with sulphur, at the rate of three pounds to 1,000 cubic feet of air-space should rid a cellar or storage house of the pests.

SPRAYING.

Spraying is an old remedy but one that is very effectual, and by far the best means at hand. A spray of paris-green put on while the apple stands upright and before it turns down, after the blossoms fall and the stamens wither, will deposit a small amount of poison inside the calyx cup, which poison after a short time, dries and remains indefinitely. Now as the majority of the first brood and sometimes the second brood as well, enter at the calyx, the poison could not be better placed. Early in the season, fruit tunneled by the codling-moth, falls to the ground, thus thinning the fruit and saving the tree from the drain of supporting damaged fruit, but later, in the case of the second brood, the case is different. The larvae get into the fruit, much of which rots, while some appears to be healthy until after it is packed and stored away, where the larvae finish their development slowly and spin cocoons in the barrels or bins. The first brood does less damage than the second, but the size of the second brood depends largely on the proportion of the first brood that lives through. A spray applied just about the time that the young hatch out, during the first week of August, should and does reduce the second brood very materially. The reason for this is found in the fact that the majority of the eggs are laid on the leaves, which readily take and retain the poison. The fact that the larvae feed, for the most part, on the underside of the leaves, makes the advantage of under spraying apparent. If more than two sprays are to be applied, they may be put on, one soon after the first application and the other about ten days or two weeks after the first August spray, the period midway between the two, being a time of comparative inactivity.

Clean culture pays without question. Clods furnish places for the larvae to pupate, and brush and prunings furnish favorite quarters for such purposes. Many cocoons were found under brush, and trees under which brush was allowed to lie, showed a corresponding decrease in the number of cocoons under the bark-flakes and bands.

PREPARATION OF INSECTICIDES.

Any one of a number of arsenical sprays may be used in connection with bordeaux mixture for the codling-moth, but paris-green is rather a favorite with the writer because of its cheapness and because its color does not permit it to be mistaken for flour, baking-powder or any other common household commodity. In the case of large growers, the cost of paris-green would be considerably more than Kedzie mixture or of white arsenic and lime. Directions for making these insecticides can be found in special bulletin 24, which is to be had for the asking. Disparene is purchased ready prepared and is said to have a great advantage in that it sticks longer than paris-green or any of the other arsenicals. Its cost is, however, somewhat greater.

The writer makes bordeaux and paris-green as follows: Four pounds of copper sulphate (blue vitrol) are dissolved in a wooden pail filled with hot water, and six pounds of stone lime (quick-lime) are slaked as finely as possible in a metal pail, with hot water. When ready stir the contents of each pail in a separate barrel containing twenty gallons of water. Now pour one pailful at a time, into a spraying barrel, taking alternately from these two half filled barrels, stirring well all the time. In this way a bordeaux of fine quality is made. To prepare the paris-green, place one-fourth to one-half pound of the unslaked lime in a small pail or crock and slake it with hot water. When reduced to the consistency of cream, add one-fourth pound of paris-green and stir with care, while the lime is hot. Add this to the forty gallons of bordeaux, stir in well and spray.

The copper sulphate should always be kept in wood as it quickly spoils if it comes in contact with metal. The easiest way to dissolve it is to suspend the crystals in a cloth bag just under the surface of the water. It dissolves much faster than if placed on the bottom of the vessel. When large quantities are to be made, it is well to make up a stock solution, dissolving a pound of the sulphate in each gallon of water in a separate barrel, so that a gallon of the liquid contains a pound of the crystals, in each case. This saves time, for we simply have to dip out four gallons of the stock solution, dilute to twenty gallons, and proceed as before. Several crocks or small pails may be kept going all the time, so as always to have a prepared stock on hand.

When large tanks are used of course larger amounts must be used, in the same proportion.

Use a fairly fine nozzle like a Vermorel, and stop spraying just before the tree commences to drip. When using the paris-green alone, mix with freshly slaked hot lime as described, only put it directly into forty-two or three gallons of water instead of forty gallons of bordeaux.

Bulletin No. 223.

ROBERT S. SHAW.

PART I.

EQUIPMENT OF SWINE DIVISION INCLUDING BUILDING, COST, YARDS, FENCES, ETC.

The Building.—Fig. 1 represents the ground plan of the College piggery as it is now fitted for use. The building itself was among the first erected at the institution for housing live stock and was constructed almost solely by student labor. It is a very old building but, nevertheless, today it contains some excellent material in almost perfect state of preservation. The excellent pine siding and the oak posts, studs, joists, rafters, sheathing and lining, bespeak of days when these materials were plentiful and so inexpensive that nothing but the choicest was used even in the construction of a piggery. The quality and value of these materials, combined with the necessity for making the best use of the material at hand, were some of the conditions requiring the refitting of the old rather than the erection of a new building. In planning and constructing a new building there should be nothing to interfere with the development of the most perfectly desirable plans; in refitting an old building conditions are sure to arise to thwart the execution of desired plans or changes. It is also possible to figure very closely on the cost of erecting a new building while estimates on reconstruction, or refitting, seldom fail to fall short owing largely to the inability to determine exactly what material must be replaced, particularly that which is covered up.

We do not present these plans desiring our readers to accept them as models for the Michigan swine raiser, for the conditions at the college are very different from those surrounding the average breeder or pork producer. While few private individuals keep more than one breed of hogs, the College is maintaining no less than seven distinct breeds for a double purpose. The primary object in keeping so many breeds is to furnish plenty of good specimens to give our students an opportunity to study, in the most practical way, the breed type and characteristics of each breed; the secondary object is to furnish stocks of desirable types for experimental breeding and feeding purposes. At present we have nine pens of experimental feeder hogs comprising fifty-two heads. The number of breeds enumerated, requiring the maintenance of several boars, and the numerous lots of experimental and breeding pigs, demand a structure with a large number of pens. The plan of the remodeled building and added equipment are therefore presented, not as models, but with the hope that here and there suggestions of value may be thrown out.

During the past few years there has been a marked increase in the advocacy and use of cots for sheltering swine during the entire year. On first thought our plans may seem to oppose this method, but such is not the case. We are using all the pens in this building and also a dozen cots in yards during the entire year, the former for boars, young pigs and experimental feeders and the latter for brood sows and young animals being grown for breeders. Both methods have their merits and demerits, but we are becoming convinced that under Michigan conditions, with our rigorous winters, a combination of piggery and cots is more desirable for the swine grower than either alone.

The ground plan in *Fig. 1* shows the form of the original building 34x80 feet, consisting of a main structure 24x80 feet with a lean-to 10x80 feet on the south side. Originally this building was fitted with a passageway 8 feet wide all the way across the north side. The remainder of the enclosed space was divided into ten pens of various widths extending from the passage way on the north to the south wall of the building. These long narrow divisions were divided in the center forming inner and outer pens; the former were used for feeding and sleeping quarters and the latter as sort of covered sheds. By this arrangement with the pens proper running down through the center of the building, there was no possibility of sunlight ever reaching the sleeping apartments. According to

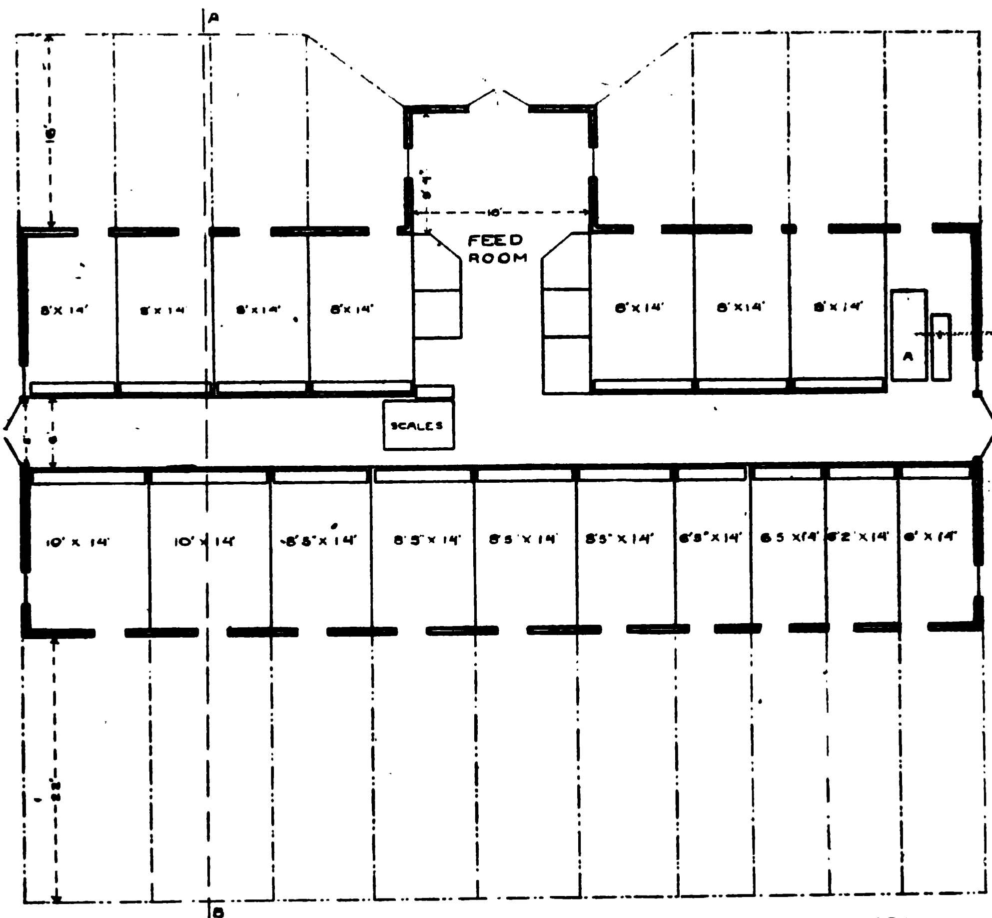
the present plan the building is divided the long way through the center by an alley 6 feet wide, thus leaving 14 feet of pen space on each side which is an ideal length for pens. The pens on the north side of the building are used for boars and the more mature feeder hogs, while those on the south, admitting an abundance of sunlight, are used by pigs, younger feeders, and to a limited extent by brood sows and their litters. Each pen has access to yardage enclosed with woven wire except the partitions between the boar yards which are constructed of boards; the outer ends of the boar pens are, however, enclosed with woven wire. The yards are the same width as the pens within and are 16 feet long on the north side of the building and 22 feet on the south side. A pair of platform scales is located in the alley at the feed room having been set down in the cement flush with the floor; this is one of the most necessary and most used conveniences about the equipment. There are many who prefer that a piggery cut through the center by an alley with pens on both sides, should be placed on a north and south line in order to admit sunshine on one side in the forenoon and on the other in the afternoon. Many of the simplest, most useful and most inexpensive piggeries are long narrow buildings with but one row of pens; in the use of this form of piggery the pens should invariably face the south.

Cross Section of Piggery.—Fig. 2 shows a cross section of the piggery at the section line indicated by A B in Fig. 1. The foundation, as shown by the illustration, consists of the stone wall originally placed under the building. Had it been necessary to replace this foundation, concrete would have been used, being easier to build and less costly. The piers on both sides of the alley supporting the posts, are constructed of concrete. The entire floor is made of concrete, and is four inches thick; the lower three inches consist of coarse gravel seven parts and cement one; the upper inch or top-dressing, consists of sharp sand three parts and cement one. The alley running through the center of the building its entire length, is six feet wide; this width rather than being a waste of space, is one of the greatest conveniences about the building. An alley placed along one side of a long narrow building need not be so wide but should not be less than four and one-half feet in the clear. Feeding alleys are almost invariably made too narrow. The six-foot alley shown in the illustration is crowned over, being one-half inch higher in the center to insure its being kept perfectly dry, and was given a rough finish to prevent animals from slipping while being driven to and from the weigh scales. A rough finish can be given by brushing the cement lightly with a steel broom after it has been laid and troweled down. The floors of the pens were given a fall of two inches from the alley to the outer doors, but this is not as necessary as was first supposed, the urine being completely absorbed when the pens are cleaned and bedded as frequently as they should be. We consider some fall to the floors desirable, but not more than has been given in this instance; the fall is necessary when the pens have to be flushed out and the whole house given a thorough cleaning and disinfection. Pen floors should also be given a rough finish.

The partitions are constructed of one and a quarter inch oak boards, the material used for similar purposes in the original fittings. The boards were cut into three foot lengths and placed in an upright position, the bottom ends resting on a two-by-four and the tops capped with similar material. The two-by-fours were not guttered to receive the ends of the upright boards as this would make it difficult to replace one should repairs be needed; the ends of the partition boards are held in place by inch strips nailed on the two-by-fours on both sides. When partition boards are placed on end with the wood fibre in a vertical position, hogs cannot gnaw them so easily as when they are placed in a horizontal position. The partitions are raised three inches above the cement floor to prevent them from rotting quickly and to permit of thorough disinfection and the maintenance of good sanitary conditions. The raised sill may become dry and can be disinfected, the one on the floor cannot. The objection to the raised sill is that pigs will work manure underneath it and care must be taken to remove this when the pens are cleaned. In order to prevent manure from accumulating under these sills, we are planning to fill this space with concrete by first tacking a board on one side and then filling the space with concrete held tightly in place by a board tacked on the other side until dry. We feel sure that this will remain in place and can be done much more easily than at the time of the floor construction. The two-by-fours forming the partition sills are fastened to posts at each end and are supported between by two pieces of gas pipe set in the cement and resting in holes bored in the wood of the two-by-four above. The top of the parti-

tion need not be more than three feet six inches above the floor. With the possible exception of the boar, a hog that requires higher fencing than this is an undesirable one to have.

The yards on the north side of the building where the boars are kept during a part of the season, are separated by board fences, this being the only safe material for the divisions between them; the ends of these pens are, however, enclosed with woven wire. On the south side the pens are constructed of woven wire, the method of construction being fully described later in this publication. On the north side of the building, the slope of the ground was such that the desired fall could not be given the yards but on the south side a fall of a little more than a foot was established in the twenty-two feet of length, giving most excellent results. The possibilities for securing a good fall in every direction from the piggery should be one of the most important factors in determining its location. Wallows in pig yards, containing the drainings from the manure pile, putrid water and other filth, are prolific breeders and distributors of disease. On both sides of the building strips of cencrete three feet wide, were laid next to the walls. This has served an excellent purpose in preventing the hogs from rooting holes and forming wallows against the foundations, thus injuring them.



M.A.C. PIGGERY.
SCALE 1"=16'
A - DIPPING VAT.

FIG. 1.

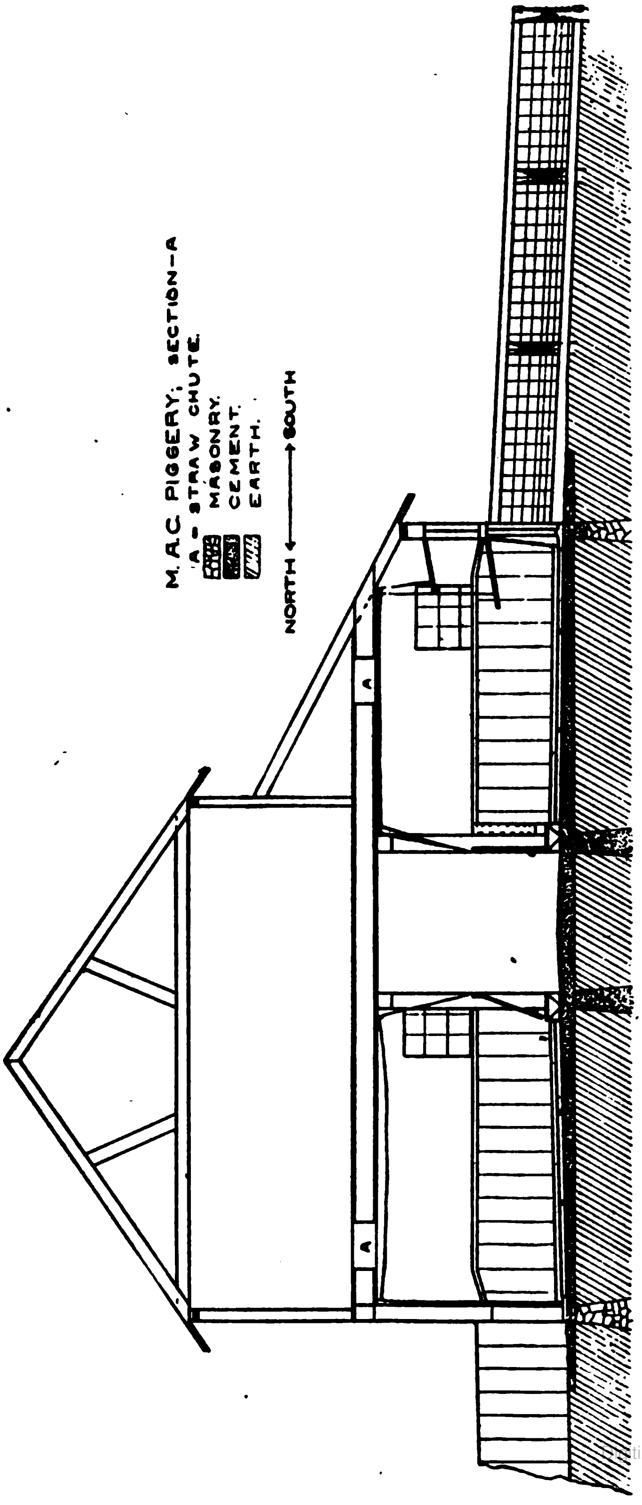

M.A.C. PIGGERY; SECTION-A
A - STRAW CHUTE.
MASONRY.
CEMENT.
EARTH.
NORTH ← → SOUTH
A
A

FIG. 2

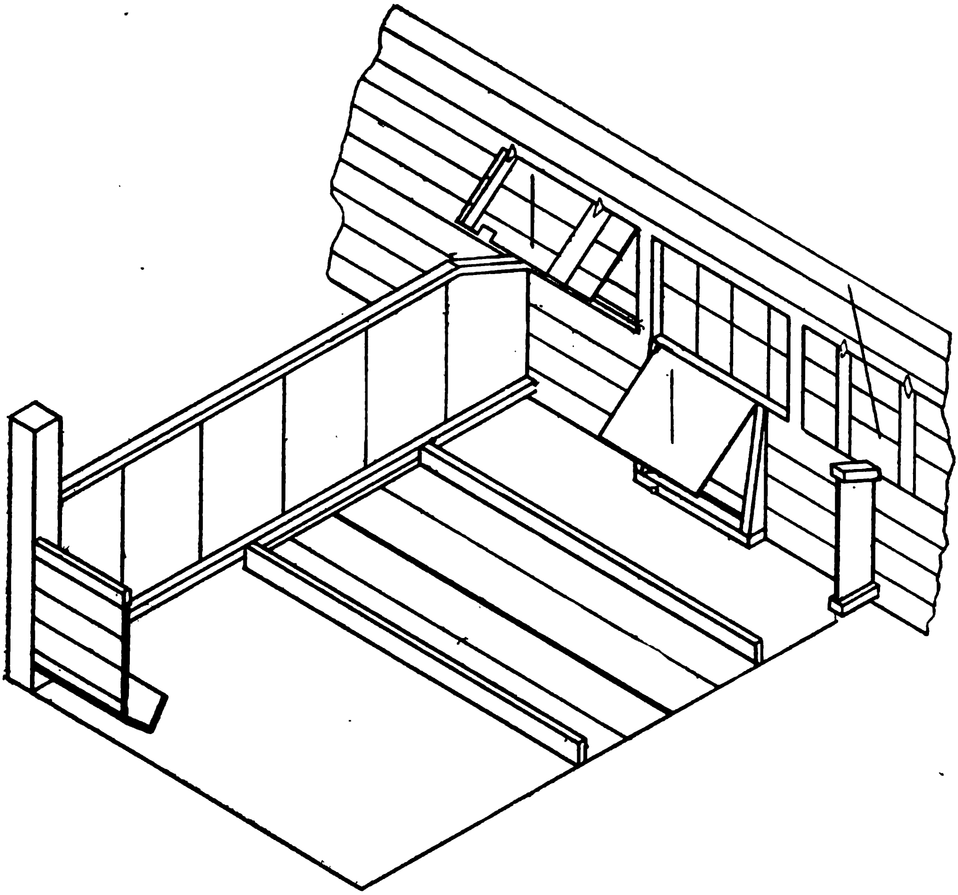


FIG 3.

The loft above is about eight feet high at the posts and furnishes an abundance of room for storage of straw, crates, crate materials, overlays, troughs, etc. No meal feed is stored in the loft. In general food stuffs stored in piggery lofts are continually exposed to extremely impure, foul smelling air.

A system of ventilation was started but still remains incomplete. In this piggery there is an average of one door, one window, and one trap above, for each pen. The traps above are seldom shut and the doors are sufficiently loose to swing. With all these openings we have not yet found an insufficient circulation of air.

This illustration also shows the ropes and pulleys by which both doors and ventilators are opened and closed from the central alley, there being no doors opening into the pens from the alley. The opening A A from loft show how the bedding is supplied to the pens.

The Pens and Their Fittings.—Reference to Fig. 1 shows the pens to vary from six to ten feet in width. It also shows that the doors opening into the yards are not all regularly located either in the center or corners of the pens. This is due to the fact that the original openings were utilized and could not be readjusted without completely reconstructing the south side of the building. The doors of all pig pens should be located in one corner; there are two reasons for this, in

the first place, if placed in the corner most remote from the direction of the prevailing wind, greater protection is afforded the pigs in the pen when the door is open, and second it allows the proper construction of overlays.

Overlays.—What they are and the necessity for their use leads to a short, but necessary, discussion of flooring materials. The plank floor which has been so universally used in the past for piggeries, has now become almost impracticable owing to the scarcity of such material and its high cost; the use of hard wood is entirely out of the question and pine floors are short lived. It is almost impossible to construct a wood floor so as to make it water tight and provide good sanitary conditions. Dry earth floors would be ideal for the sleeping quarters for pigs

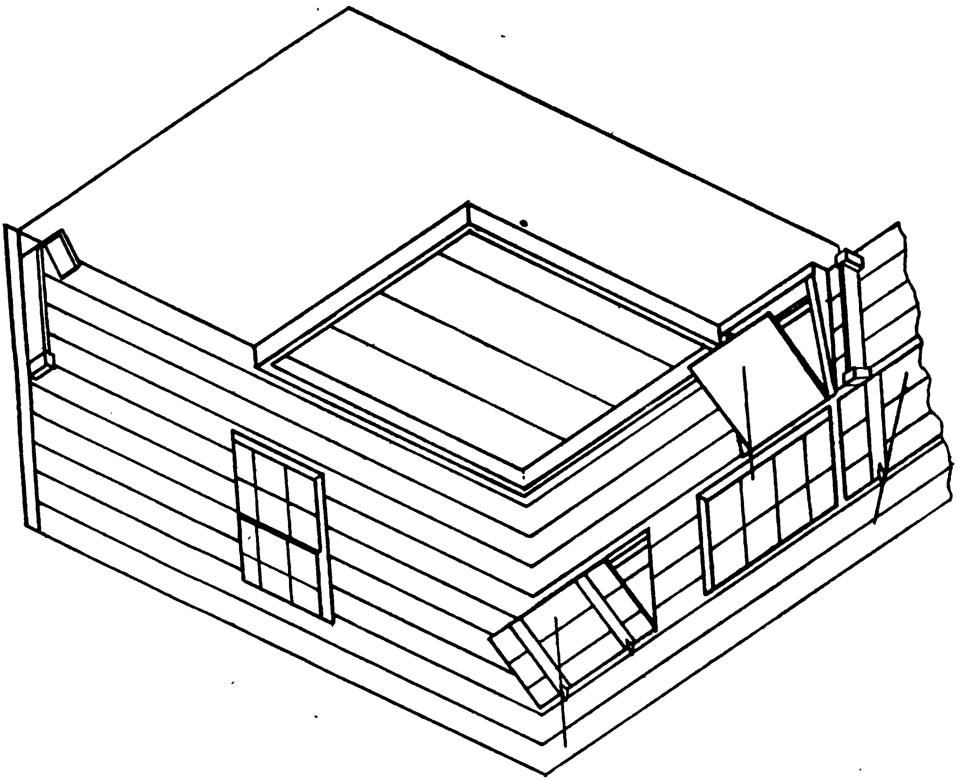


FIG 4.

if they could be kept dry and clean. At the present time there is no floor in use in piggeries more desirable or inexpensive, considering durability, than one properly constructed of concrete nor can as good sanitary conditions be maintained by the use of any other. And yet, notwithstanding these good qualities, cement floors are strongly objected to, and justly so too, on the ground that pigs become crippled if required to nest in beds on them during the winter season. Even though an abundance of bedding is used on cement floors, bad results seem to follow just the same. There are few worse places for a brood sow to farrow than on a cement floor. She gathers the small amount of bedding allowed her into a small pile, beds on it and the newly born pigs wriggle off on the bare floor, which being slippery, prevents them from getting on their feet, the cold floor soon exhausts them, and they perish. It was with the object of overcoming these objections to the cement floors that overlays were used.

Figs. 3 and 4 show two pens, each ten by fourteen feet but with two different forms of overlay. Fig. 3 shows an overlay running across the center of the

pen; this form was used because of the outer door being in the center of the pen, thus leaving insufficient room for the overlay in the corner. This overlay is in two sections, each two and one-half feet wide so that it can be lifted easily in cleaning out the pen or thrown out in the sun to dry, or put in the loft for storage during the summer. The two sections are held in place by four blocks tacked on the two-by-fours at the bottom of the partitions. This arrangement leaves plenty of room for feeding at the trough and space for the manure near the door. The greatest objection to this form of overlay is that because of its

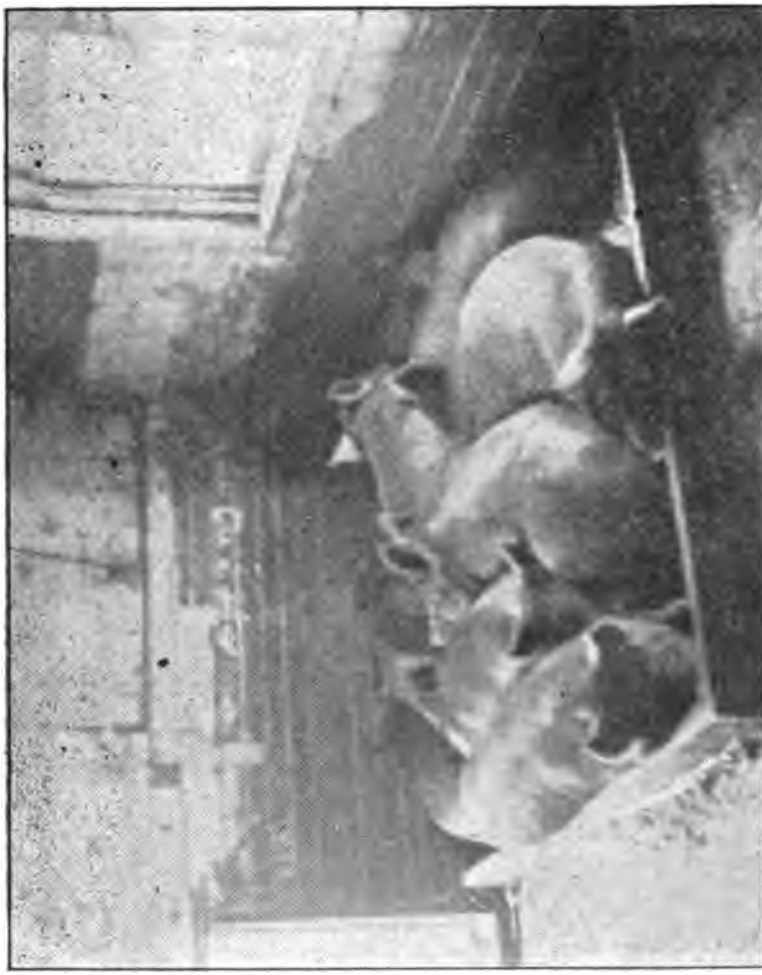


ILLUSTRATION 1.

location between the trough and door, the pigs have to cross it frequently, thus not only soiling it but dragging the bed off on the floor as well. This objection is sufficient to urge strongly against this form of overlay. Fig. 4 shows an overlay 6x8 feet in one corner of a pen with the door in the opposite corner. This plan is possessed of the advantages of providing more shelter for the bed when the outer door is open and the pigs can go in and out without crossing the bed. The accompanying *Illustration 1* shows nine 180-pound pigs bedded down comfortably on this overlay. This latter form of overlay is hinged to the wall so that when the pen is cleaned out it is tipped up, bedding and all, and any filth

which may have accumulated underneath is cleaned out. When the floor is cleaned, the overlay is let down and the bedding thrown off on the floor for absorbent being replaced by fresh straw at least once a week. When the overlay is placed in the corner of the pen, that portion of the floor should be raised somewhat.

Both forms of overlay, now in use in the piggery, were constructed from second hand inch lumber; they are raised off the floor by inch cleats which hold the boards together. A two-by-four was set up around the outer edges of the overlay to hold the bedding in place. (A two-by-six may be used.) These were nailed to the boards below and strengthened by triangular pieces of scantling fastened in the angle formed by the two-by-four and the board floor. In the use of these overlays three facts have been strikingly noticeable, viz.: First, pigs invariably use the overlays, by preference, sleeping on the bare board if there should be no straw on them; second, of the three or four hundred hogs that have been housed in this piggery there are few instances where the bedding on the overlays has been befouled by excreta and the tendency to this is much less in the case of the overlays in the pen corners where the pigs are not trampling over them; third, we have not had a crippled hog in the piggery since these devices have been in use. We dislike the plan of boarding or planking over the entire cement floor surface of a pen during the winter even for farrowing, as dung and urine work in between and under the boards or planks producing very unsanitary conditions.

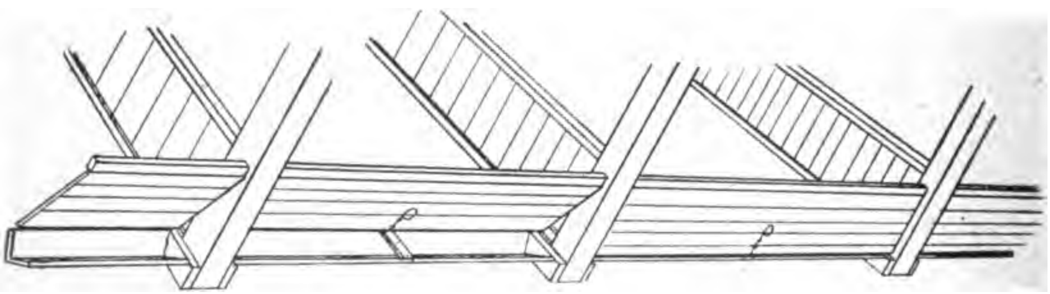


FIG. 5

Figs. 3 and 4 also show one of the two forms of doors used in the piggery. These doors swing inward from the top and are opened from the central alley by a small rope operating over two pulleys as shown in Fig. 2. A light steel rod shaped door spring, fastened to the casing and top of door, forces it shut. Both the door casing and sill are widened by a two-by-six inch boxing which prevents the pigs from getting their noses under the bottom or side of the door to get out. A pig can come in but cannot get out if the door is closed. The only objection to this form of door is that an extremely severe southerly gale pushes them open a little and lets in too much cold; this is prevented by the use of small bolts for emergency cases. On the north side of the building the doors were constructed to slide up and down, but these could not be used on the south side without shutting off some light, the windows being directly over the doors. In addition to a door, each pen on the south side has a window above it and also a hinged panel to one side of the window which may be opened in suitable weather to admit additional sunshine and fresh air.

Troughs. Fig. 5 shows the feeding troughs with swinging partitions suspended over them in such a way that when swung back the pigs are shut away from the troughs while the feed is being supplied, and when swung forward again in place, they have access to them. This is no new invention for the device, with many modifications, is used in numerous farmers' piggeries. The only wonder is that it is not more universally used. The top of this swinging partition consits of a two-by-four from which the three-foot partition made of inch boards swings by hinges. This partition is held in place at all times by a half-inch iron rod which slips up and down in staples, being received at the bottom in holes bored in a hardwood cleat nailed across the center of the trough. This fastening prevents the pigs from moving the partition at any time. If the pens

are over ten feet in width the swinging partitions are too cumbersome to work well. They should not be made to swing into the pen past the edge of the trough when fastened or the pigs will soon gnaw the edge of the bottom board off. These partitions are made to swing back until they stand straight up overhead resting at the ends between the posts. This permits pigs to be driven out or in, or the cleaning of the pens from the alley. In this case doors connecting the alley and pens were purposely omitted.

The troughs are made of two-inch hemlock constructed in a V shape, one side being two-by-ten inch material and the other side and ends two-by-eight. These troughs are simply toe-nailed in between the division posts so that they can be removed easily and replaced when necessary. We like the V shaped troughs in preference to any flat-bottomed sort, in the piggery, because the pigs can clean them more readily and thoroughly and there is practically no contact at the floor except for the short end pieces; as a result filth and moisture do not accumula beneath them. On the under side of the V shaped trough, next the alley, the floor is always dry and on the pen side it can be cleaned thoroughly and is always exposed to the air. Hemlock troughs last from two to five years, or even longer, particularly if protected by a strip of band iron on the inner edge. Sloppy feed does not chill or freeze in wood troughs as readily as in cement or metal. We like flat bottomed troughs for out door feeding where they are moved about frequently, they are not upset so readily as the V shaped ones. We also like low sided, flat bottomed troughs for weanling pigs.

Hog Cots.—Reference has already been made to the desirability of hog cots to use in connection with the piggery. When climatic conditions are not too rigorous, cots only are employed for handling the entire herd. In general, the climatic conditions in Michigan are too extreme to permit the use of cots for all classes of hogs for all purposes during the entire year. They are especially desirable, however, for dry brood sows and young males and females being reared for breeding purposes; it is in this way we are using them. They are desirable because an abundance of fresh air, sunshine and exercise are provided. During the summer season cotting and yarding nearly all classes of pigs cannot be excelled.

Fig. 6, 7 and 8 represent three forms of cots now in use at the Michigan Agricultural College. Figs. 6 and 7 are forms which have been in use at the institution for some years. The form of cot shown by Fig. 6 is desirable in that it is warm in winter but objectionable in that it provides little protection against the extreme heat of summer. It is also considered a good form of cot for the brood sow to forrow in in moderate weather as she cannot lie down close enough to the sloping roof to crush her pigs as against a wall. A general mistake is made in fastening this form of cot permanently to the skids, or runners, on which it is built. These are the first to decay and along with them the lower ends of the boards, thus making repairs impossible even though the balance of the structure remains sound. A separate pair of skids should be constructed for this or any other form of cot so that they can be replaced. Its own weight will hold the cot in place on the skids while being moved.

Fig. 7 shows a form of hog cot, six by eight feet with perpendicular sides and a flat though slightly sloping roof. This form of cot is made in five separate pieces, the four sides and top, so constructed as to bolt together at the four corners. This form of cot is warm in winter and too warm in summer with its flat top exposed to the sun's rays, and though it may be planned so that the top can be raised in summer, there is trouble from the wind occasionally unroofing it. It is also objectionable in that the sections are too heavy for one man to move and as a result it is not moved as frequently as hog cots should be. All cots should be furnished with skids so that they can be moved frequently by a team and one man and not taken to pieces and moved in sections.

Fig. 8 represents a form of cot recently designed and constructed and now in use in our hog lots. It is six by eight feet at the foundation with the sides raised perpendicularly three feet before receiving the half pitch roof boards. The center boards on the sides are hinged so that they can be swung open in hot weather; the opening thus made is covered with strong woven wire, clamped above and below between inch boards; the inner clamp boards project an inch beyond the outer ones, thus breaking the joints and preventing any draught when the openings are closed. The two ridge boards are also hinged so that they can be opened during hot weather. These openings permit a free circulation of air which not only lowers the temperature but greatly relieves the oppression

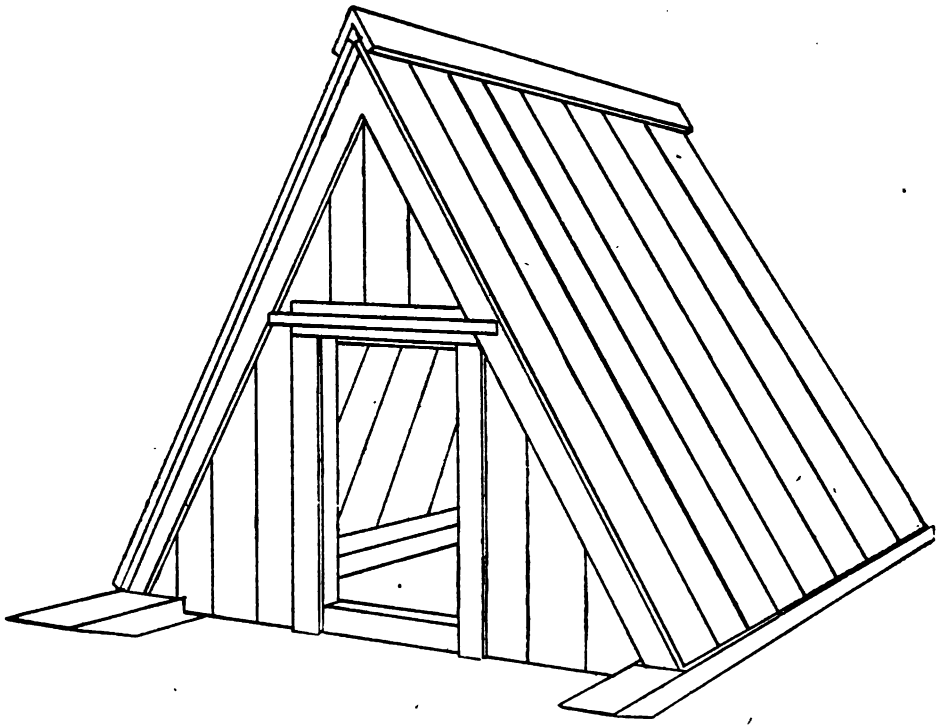


FIG. 6.

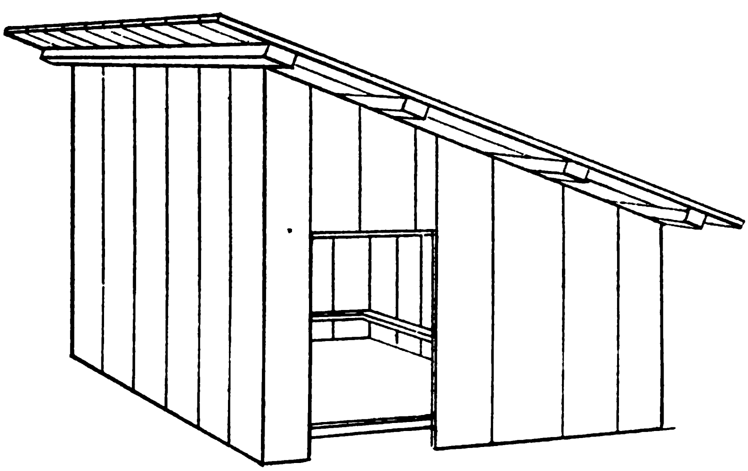


FIG. 7.

of the pigs seeking shelter. These openings close down tightly leaving warm quarters during the coldest weather. The cots proper are supported on skids to which they are not attached, being held in place by the blocking of the ties across both ends. A two-inch bottom is used or not, as desired; this flooring is cut in lengths to fit crosswise and rest on the skids which are wider than the sills. This form of cot is not desirable for the farrowing sow without the addition of a railing around the perpendicular walls a few inches from the floor to prevent her from overlaying her pigs. Probably the chief objection to this structure is the expense of material and cost of construction. It contains 160 feet stock lumber, 60 feet matched, 20 feet four-by-six, 12 feet four-by-four, and 44 feet two-by-four and required two days labor in construction.

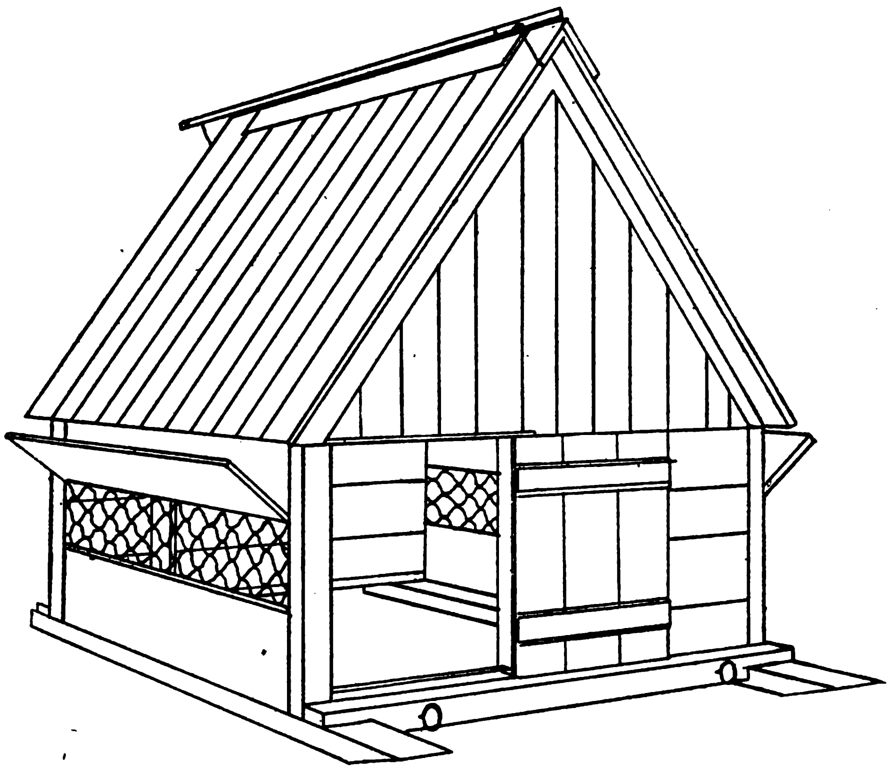


FIG. 8

Yard Fences.—The question of cheap, durable, and serviceable fencing for the small yards adjacent to the piggery is an important problem. During the past, lumber in various forms has been converted into fences of different styles for this purpose, but now its scarcity and high price renders its use almost prohibitive. A tight board fence probably makes the most perfect one for turning hogs. We have attempted to make a suitable substitute, in large part, for the lumber except in the case of the divisions between the boar pens. The fences forming our small pens are constructed of woven wire with two-by-six inch material at bottom and top. The plan is shown in *Fig. 9*. Cedar posts are placed, in this case, a little less than eight feet apart. (They should not be more than this distance for pen fences.) The posts were notched out at the bottom and top one-inch deep and the width of the two-by-six. Thus, the two-by-sixes, when firmly spiked in place, instead of being flush, projected an inch out from the surface of the post. The 26-inch woven wire was placed on the posts with top and bottom wires just

touching the two-by-sixes. The woven wire was not stapled to the end posts but each strand brought around the post and wrapped on itself. The wire fencing was also stapled to the intermediate cedar posts and the top and bottom wires to the two-by-sixes against which they rested.

The woven wire used was special hog fence with seven lateral wires, top and bottom wires No. 9 and intermediate No. 12. There are twenty-eight No. 11 cross

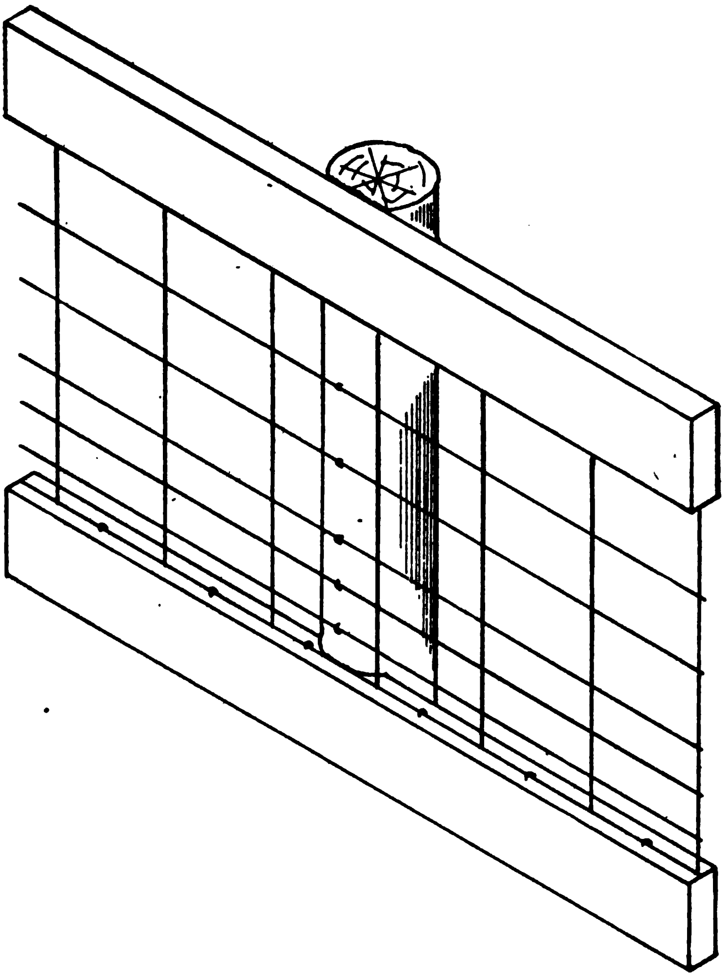


FIG. 9.

wires to the rod. The woven wire and two-by-sixes make the fence thirty-eight inches high. This has furnished a cheap fence and after three seasons' use we are perfectly satisfied with it. But one repair has been made and that at a point where a flaw occurred in the wire. The openings of these pens consist of doors which slide up and down in grooves at the sides, dropping into slots at the bottom to prevent pigs from opening them.

Lot Fencing.—The term lot is here used to designate larger enclosures, such as those furnishing pasture and forage crops. In pursuing economic methods of swine husbandry, pasture and forage crops are essential throughout the greatest possible portion of the year. Few crops provide continuous pasturage throughout

the growing season and even those which do may require resting spells for recuperation. Continuous pasturing and foraging by hogs is largely dependent on a succession of these two classes of crops. As a small area can be made to produce sufficient green crop for large numbers of hogs, this fact, in addition to the two already stated, would seem to require either a number of small lots or one large one subdivided by portable fences or hurdles. Portable fences constructed of light lumber have been commonly used in the past, but this material is no longer practicable under general conditions. If the number of hogs on a farm will

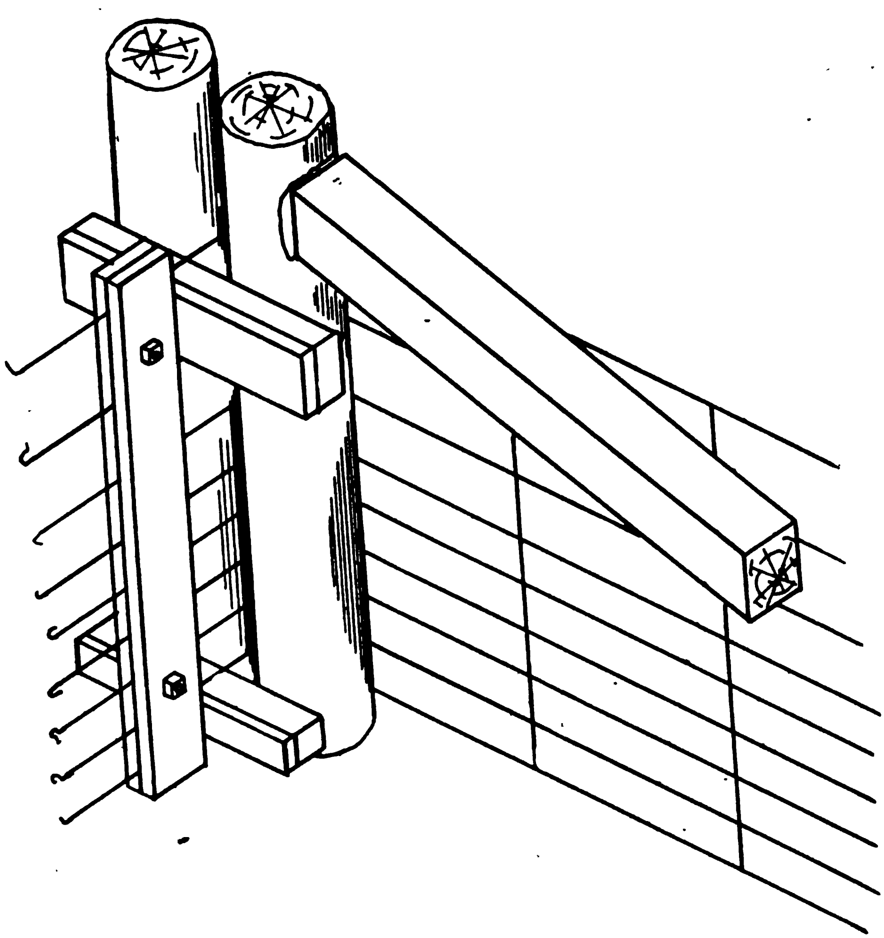


FIG. 10.

justify the growing of say six acres of forage crops, this should be enclosed and divided through the center by permanent fences. Division of the two halves can then be made by means of a portable woven wire fence as follows: Set a row of posts two rods apart across each half for the support of the portable fence; owing to the distance between the posts they will not interfere seriously with cultivation. *Fig. 10* shows a contrivançe devised for the attachment of a portable woven wire fence at the ends. Two posts cleated together at both top and bottom about four inches apart, are set in line with the fences at each end. If the woven wire is stapled to the end posts firmly enough to hold it, the fence will be badly damaged in withdrawing the staples to remove it, so that it would soon be de-

stroyed. In order to overcome this difficulty, we bolt two pieces of one-by-four inch oak in the fence in the form of clamps, placing these clamps one on each side of an upright wire to prevent slipping of the laterals. This is then drawn through between the two posts at one end and blocked by two-by-fours. A wire stretcher is then attached to the other end; the fence is pulled up tight; the end drawn through between the end posts and clamps and blocks used as heretofore described. The stretcher can then be slacked back and removed. The wire fence is held in an upright position against the intermediate posts by staples

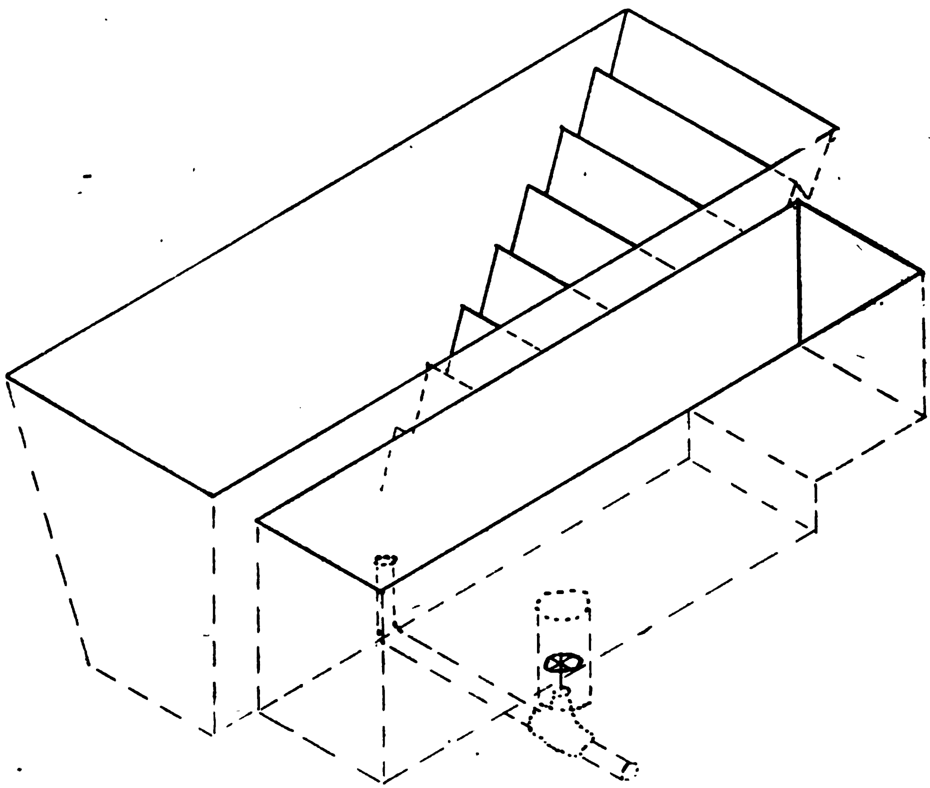
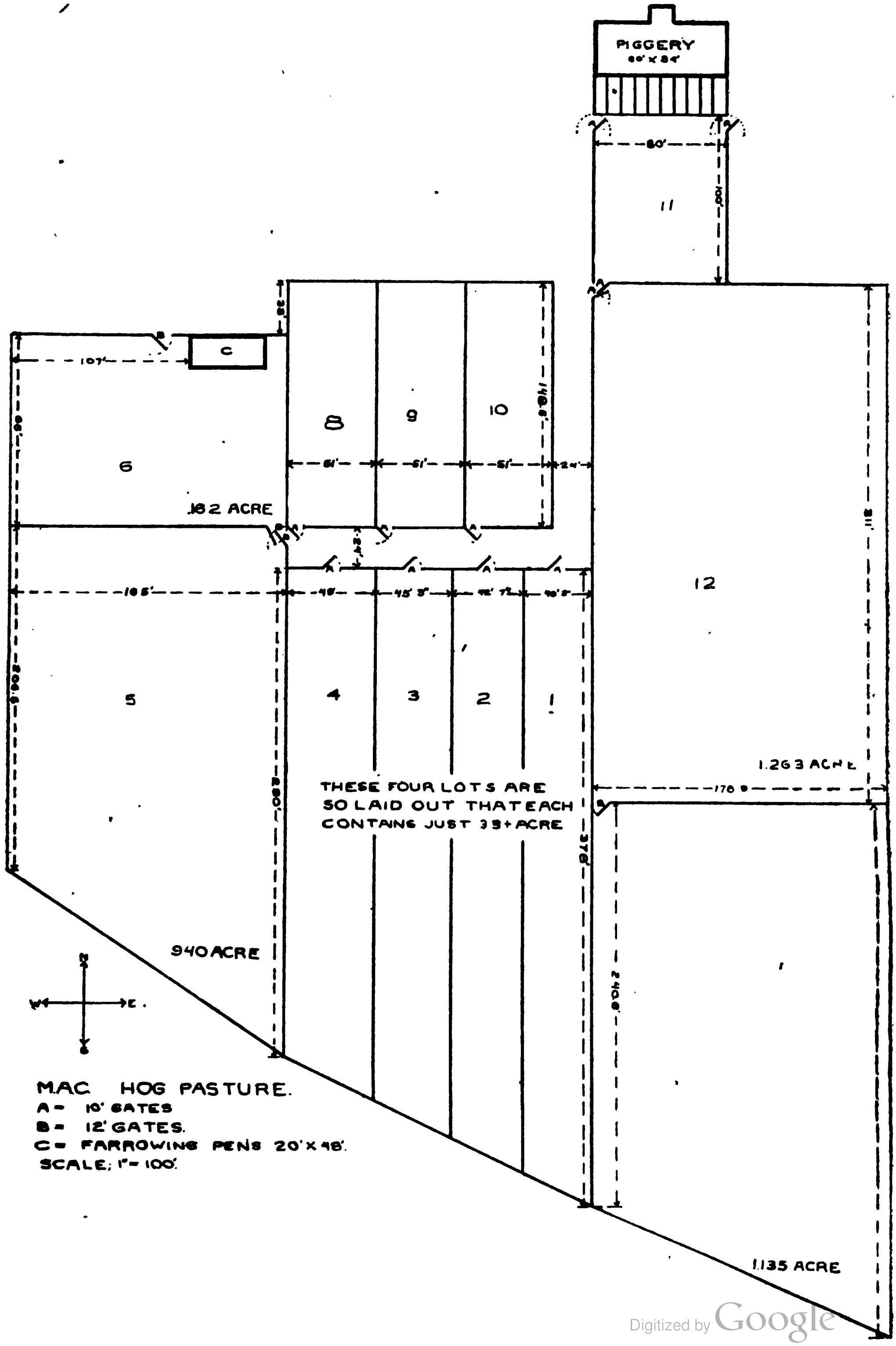


FIG. 11.

only partly driven. It required but two hours to release, move and again set up 358 feet of fence this way. In some cases it may be necessary to pin the fence down between the posts, but the occasion for this seldom occurs till the feed becomes too short. Occasionally sags will occur in the ground where pins would be lifted by the tension of the wire. In such cases the fence can be held down in the following manner, viz.: Wrap a short piece of wire around a rock, bury this underneath the fence and fastens the bottom strand of the fence down to the wires which project above ground from the rock. For portable fencing we have used thirty-inch woven wire which seems to be plenty high enough. A strand of barbed wire affords effective restraint when placed underneath a woven wire fence and is particularly desirable beneath permanent ones.

The Dipping Vat.—Fig 11 represents the form of dipping vat in use in the piggery, the location of which is shown in Fig. 1. This vat is constructed entirely of concrete. It is three feet deep, seven feet six inches long on top and three feet six inches long on bottom. It is eighteen inches wide on the bottom and thirty at the top. The end next the passageway is perpendicular, requiring the animals



PIGGERY
80'
11
100'
8
9
10
51'
51'
51'
24'
148.8
6
107'
C
182 ACRE
185'
48'
45' 3"
42' 7"
40' 8"
12
1.263 ACRE
170.9
5
4
3
2
1
THESE FOUR LOTS ARE
SO LAID OUT THAT EACH
CONTAINS JUST 35+ACRE
940 ACRE
1.135 ACRE
N
W
E
S
MAC HOG PASTURE.
A= 10' GATES
B= 12' GATES.
C= FARROWING PENS 20'X48'.
SCALE; 1"=100'.

FIG. 12.

to plunge in; the other end is sloping with creases in the cement forming little steps to enable sheep and hogs to walk out. Adjacent to the vat and separated from it by an eight-inch cement partition, is a dry chamber five and one-half feet long, two and one-half feet deep, and eighteen inches wide, for an attendant to stand in and hold or handle sheep, as the vat is used for both sheep and hog dipping. One end of this chamber is raised nearly a foot to enable the attendant to assist sheep up the incline. The cement floor around the vat is so graded that the drippings are returned to it. This illustration shows, also, the drain pipe leading to an underdrain with the valve in the dry chamber below the floor level of this part. This vat was easily constructed, inexpensive, durable, and is entirely satisfactory.

PART II.

FORAGE CROPS FOR SWINE.

Fig. 12 represents the arrangement of the lots for swine. In 1903, lot 1 produced rape, lot 2 succotash, lot 3 peas and oats, and lot 4 sugar beets; in 1904, lot 1 produced succotash, lot 2 peas and oats, lot 3 sugar beets and mangolds and lot 4 rape. No. 5 is a permanent June grass pasture and No. 6 furnishes yardage for sows and young pigs housed in the brooder house C. No. 7 grew cow peas, soy beans and carrots in 1903 and rape in 1904. The lots numbered 8, 9, 10, 11, and 12 are used almost exclusively for yardage for exercise.

The permanent fences surrounding this area consist of forty-eight and fifty-eight inch woven wire; the inner divisions vary from thirty to thirty-six inches as heretofore described. The gates are ten and twelve feet in width, wide enough to permit the passage of a team and the necessary implements of tillage, as well as the movement of hog cots. The gates A A and B B are hung to overlap so as to turn hogs either one of two ways without inconvenience. This arrangement of lots permits of the production of a variety of forage crops and the carrying out of a very intensive system. Such minute subdivision and the growth of all the varieties we are using, may not be necessary under the average farmer's condition. We desire it to be emphatically understood that this report of forage experiments is merely preliminary. It is the purpose to continue these lines of work until unquestionable results have been secured.

Succotash for Swine 1903 and 1904.—In 1903 lot No. 2, Fig. 12, was sown to a succotash mixture on May 8th; the ground was spring plowed. This mixture consisted of corn 1 peck, peas 1 peck, oats 1 peck, and barley 6 quarts. The mixture was sown by an ordinary grain drill at the rate of 2½ bushels per acre. This crop was not pastured off by hogs as intended, owing to inability to finish the necessary fencing before the succotash got too large to pasture. It was cut and weighed immediately after the time of cutting, between June 24th and July 6th, yielding 7,629 pounds of green fodder from the one-third acre. At this rate one acre would have yielded 22,887 pounds, or 11.44 tons. The growth was dense and tall; all the grains showed well except corn, which was from poor seed.

In 1904, lot 1 Fig. 12, was sown to a succotash mixture, differing slightly from the previous year; this crop was sown May 7th and was preceded by rape in 1903. In this case the mixture consisted of corn, oats, peas, rape and millet sowed in the following manner. After the ground had been prepared for seeding, a mixture of millet and rape, equal parts, was sown broadcast on the land by hand using a pint of each to the one-third acre. The corn, oats and peas in equal parts by measure, were then mixed and sowed by a grain drill at the usual depth, the same operation covering the rape and millet lightly. All the plants of this mixture made a good even start except the millet which grew slowly, but some soon outdistanced the others. *Illustration 2* shows the relative size and proportions in which these five plants grew in the mixture. The plants were secured by cutting out two or three small areas, representative of the lot, and then separating out the plants of the various sorts which were photographed for this illustration. These samples were taken July 12th, at which time the entire crop averaged three feet in height, but many of the pea vines were much longer than this.

Millet. Rape. Corn. Oats. Peas.

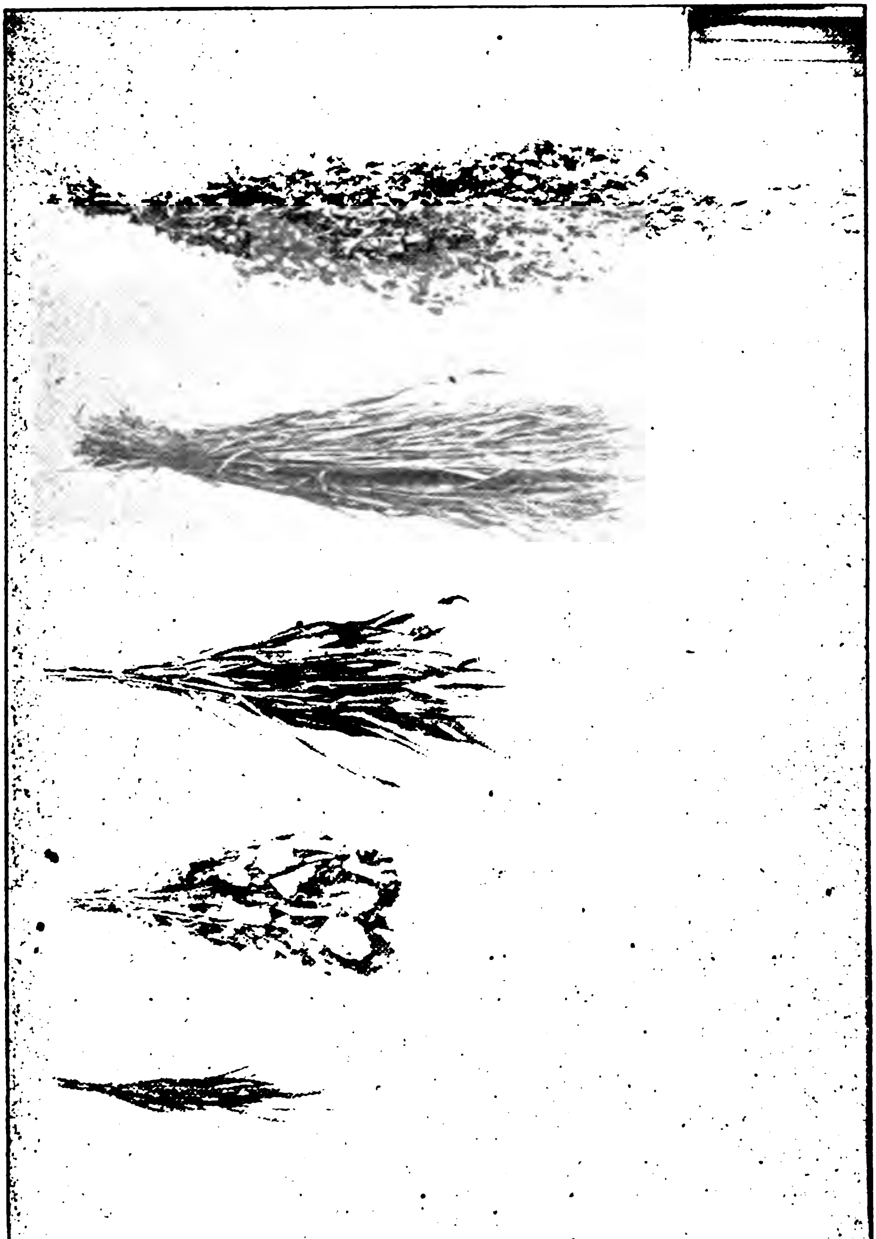


ILLUSTRATION 2.

ILLUSTRATION 3.

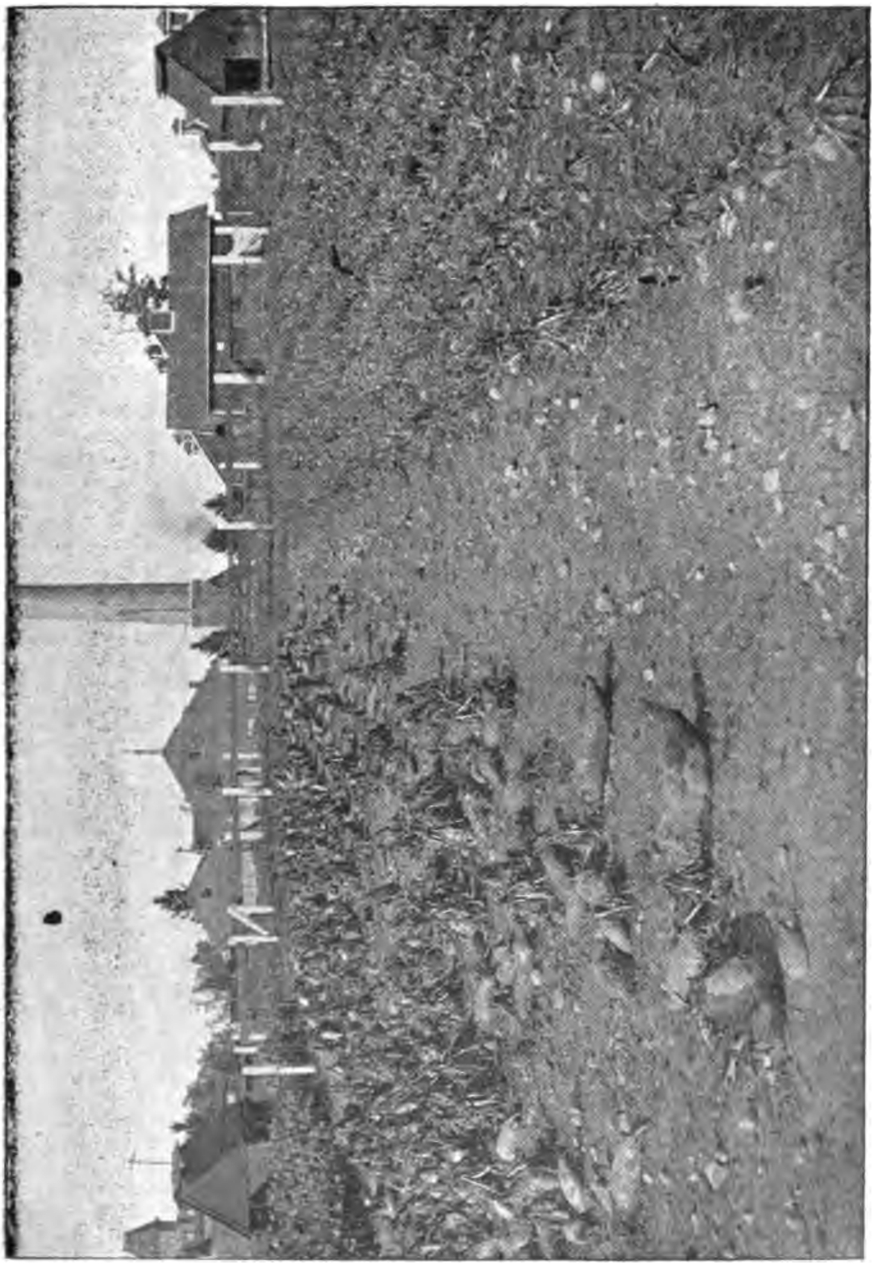


ILLUSTRATION 4.

This lot of succotash was foraged off by sixteen young pigs turned in on June 20th, at a weight of 1,208 pounds; they foraged on the lot thirty-two days, receiving at the same time some supplementary grain food. *Illustration No. 3* shows some of the pigs foraging. As this was the first of a series of experiments with three different classes of hogs, the detailed results will be given later. Where this crop was grazed off, the rape plants were bitten off so close to the ground that they failed to grow again. On another lot, however, grown in exactly the same way but cut and used as a soiling crop for dairy cows, the rape made a second growth which some six or eight weeks later was about knee high. This mixture proved to be an excellent one for dairy cows; the small amount of rape present in first cutting, did not appear to effect the milk at all, while the peas furnished considerable of the much needed protein.

Through the courtesy of F. W. Robison, Station Chemist, we received the following results of the analysis of the 1904 succotash mixture with the results expressed on "dry air" samples as follows, viz..

Moisture	8.30%
Ash	10.35%
Protein (total nitrogen)	15.09%
Proteids (true)	14.30%
Amido bodies	.79%
Ether extract	5.45%
Crude fiber	27.01%
Carbohydrates (not fiber)	33.8%

The sample analyzed consisted of the remixed materials shown in the illustration No. 2.

Peas and Oats as Forage for Swine, 1903 and 1904.—In some localities peas are quite commonly grown until they nearly reach maturity, when hogs are turned in to feed upon the grain and such of the forage as they may desire. Our tests of 1903 and 1904, to determine the feeding value of this forage crop for hogs, gave the following results, viz.:

Test of 1903.—On May 9th, 1903, lot 3 Fig. 12 was sown to a mixture consisting of peas three parts, and oats one part, by measure, at the rate of 2¼ bushels per acre, a seed drill being used. Oats were used along with the peas to hold them up off the ground and prevent mildew. On August 14, 1903, when the peas were just past the cooking stage, seven pigs weighing 780 pounds were turned in the lot to forage. By September 10th, the peas, most of the oats and some forage, had been consumed and the pigs had received no other food though water was regularly supplied. On this date the hogs were removed at a weight of 850 pounds. This one-third acre of peas and oats, therefore maintained 780 pounds live hogs 27 days and produced a gain of 70 pounds. At this rate one acre would maintain 2,340 pounds live hogs 27 days and produce 210 pounds pork.

Test of 1904.—In a manner like unto that just described, peas and oats were grown in lot 2 Fig 12, in 1904, which had produced succotash in 1903. The mixture was sown May 7, 1904, and seven hogs weighing 1,321 pounds were turned in August 4th with the grains at about the same stage as the preceding year. On August 17th, after thirteen days, these hogs were removed weighing 1,376.5 pounds, making a gain of 55.5 pounds. This one-third acre of peas and oats, therefore, maintained 1,321 pounds of live hogs thirteen days and produced a gain of 55.5 pounds. At this rate one acre would maintain 3,963 pounds live hogs thirteen days and produce 166.5 pounds gain.

These two tests were conducted under exactly the same conditions. Both years the growth of pea vines was excessively heavy at the expense of grain production, due, largely, to the exceeding richness of the soil on which the crop was grown, and the very wet season. Some of the oats were apparently smothered but sufficint grew to hold the peas up fairly well; these oats matured and were not quite all gleaned by the pigs as shown by the appearance of a vigorous volunteer crop later in the season. No peas were left, however. These results in pounds of pork are considerably less than we should expect from an acre of peas, producing twenty bushels of grain and the small gain is no doubt due to the soil and climatic conditions which stimulated vine and leaf growth at the expense of the grain.

Sugar Beets and Mangolds as Forage for Hogs 1903 and 1904.—During the past

two years, sugar beets and mangolds have been grown for hog forage, the plan followed being to turn the hogs into the lots early in the fall and allow them to do their own harvesting. Some supplementary grain was fed while the pigs were consuming roots because of their inability to consume sufficient of these to get the required amount of dry matter.

Test of 1903.—Lot No. 4 Fig. 12, previously used as a hog run, was sown to sugar beets May 12, 1903. This lot was spring plowed and did not break up good and a portion was water-logged late into the season. After the ground was prepared, it was marked off into rows two feet apart and sowed with a hand garden drill; the time required for these two operations was two hours time of one man. The crop was hand wheel hoed as soon as it came up and as often thereafter as ncessary. The roots were thinned to eight inches in the row and grew to a much larger size than those desired for factory use.

On September 29th, sixteen hogs weighing 2,049 pounds, were turned in upon the sugar beets. These were removed November 7th, at the weight of 2,633 pounds, having gained 584 pounds. During these forty days, however, 350 pounds middlings and 1,205 pounds middlings and corn meal, equal parts, was fed to these hogs. According to W. A. Henry's "Feeds and Feeding" the meal fed would nearly account for the maintenance of these hogs, 1.88 pounds of meal being supplied each day per 100 pounds live weight, or the 1,555 pounds meal fed would account for 345½ lbs. of the increase and part of the maintenance, allowing 4½ pounds meal per pound gain. And the sugar beets would account for a part of the maintenance and the production of 238.5 pounds pork. Thus, if one-third acre produced a gain of 238.5 pounds, one acre would produce 715.5 pounds, which valued at 5 cents would equal $37.77, return from one acre of beets in the form of pig feed.

Test of 1904.—On May 7, 1904, lot No. 3 Fig. 12, which has produced peas and oats in 1903, was sown to sugar beets and mangolds, there being eleven rows of each. This crop was cultivated in about the same manner as that grown the previous year. In order to get at least some idea of the relative yields of the mangolds and sugar beets, the two adjacent rows of each were pulled, topped and both roots and tops weighed the day before the experiment began; these were afterward thrown back to the pigs. These two rows of roots were 308 feet long and the distance between them was two feet. The row of mangolds weighed 1,060 pounds and their tops 430 pounds, which estimated gives 37.4 tons roots and 15.2 tons tops per acre. The one row of sugar beets weighed 560 pounds and their tops 510 pounds; the estimates from these figures give 19.7 tons beets and 18 tons tops per acre. We recall the fact that these lots, which had been hog yards for years previous, were very rich, the conditions being especially conducive to the growth of tops

On October 3d, twelve cross-bred hogs weighing 1,329.75 pounds, and four pure breds weighing 438.5 pounds, making a total of 1,778.25 pounds, were turned in upon the roots where they remained till December 12th. The ground, of course, froze up before this but the then remaining roots were pulled, piled and covered so that the hogs still had access to all they could eat. On December 12th, the twelve cross-bred hogs weighed 1,840.5 pounds, and the four pure breds 537 pounds. (The light gain of the four was due, in some measure, to the uncongenial spirit manifested them by the twelve.) In 70 days, therefore, these hogs gained 598.25 pounds, but 752 pounds middlings and 752 pounds corn meal had also been fed them during this time, or about one and one-fifths pounds meal mixture per day to each one hundred pounds live weight of hogs turned in the lot, or about one-third grain ration daily. Allowing 4½ pounds meal for maintenance and the production of one pound pork, the 1,504 pounds meal would be responsible for 334.2 pounds of the gain; this would leave a part of the maintenance and the production of 246 pounds of pork to the credit of one-third acre of roots, or 792 pounds pork per acre, worth at 5 cents, $39.60. In this last experiment the proportion of meal furnished to the live weight of the hogs was less than in the first case.

It was observed that the pigs consumed the mangolds first, as shown by *Illustration No. 4;* it may have been because they could be secured more readily. Owing to the fact that the mangolds stood up high out of the ground, they were soon tipped over and left exposed to the sun during the day and the frosts at night; for this reason and the fact that sugar beets are less easily damaged by frost, it is fortunate that the mangolds were consumed first. Pigs scour con-

siderably when turned in on roots in this way unless considerable dry feed is given the first few days. Butcher hogs come off this kind of feed paunchy and require three or four weeks grain feeding to fit them for market. This method should bring breeding stocks into winter conditions in strong vigorous shape. The pigs will dig all roots out even to the very tips, unless the ground freezes. We did not use sufficient hogs in these tests, nor turn them in quite early enough.

Maintenance of Brood Sows on June Grass and Rape, 1904.—It is now generally conceded that it is very desirable to keep brood sows on pasture and forage crops as much as possible during the growing season. There are two reasons why this practice is desirable; in the first place it is the cheapest food of maintenance, and in the second place, the exercise required to secure the food and the fresh air and sunshine, are conducive to physical conditions favorable to the production of litters of strong, vigorous pigs. Owing, however, to the bulkiness and watery condition of these foods, care should be taken to supply, in addition, some substanial grain foods or mill by-products, as the period of pregnancy advances. The following very satisfactory results have been secured from the maintenance of brood sows on June grass followed by rape.

WEIGHTS OF FIVE DRY SOWS DURING TEST OF 105 DAYS.

	Weight May 27, 1904.	Weight July 9, 1904.	Weight July 25, 1904.	Weight Aug. 6, 1904.	Weight Sept. 9, 1904.	Gain or loss.
Poland China	298	283	281	183	291.5	—6.5
Old Tamworth	366	358	359	353	379.5	+13.5
Poland China No. 1	194	180	173.5	176	180	—14
Poland China No. 2	159	171	163	177	174	+15
Poland China No. 3	170	163	155	157.5	164	—6

These five sows were turned on June grass May 27, 1904, rape July 9th, June grass again July 25th, and returned to rape August 6th, where they remained till September 9th, in all covering a period of 105 days. No grain or supplementary feed of any sort was given during the entire period, though the sows had access to water and shade. During these 105 days there was an increase of two pounds in the weight of the bunch. Owing to the smallness of this gain the only inference we can make is that June grass and rape provide only for the maintenance of these animals. The shortness and dryness of the June grass toward the end of the period, ending June 9th, accounts for the slight shrinkage at that time.

OBSERVATIONS ON THE INFLUENCE OF NODULES ON THE ROOTS UPON THE COMPOSITION OF SOY BEANS AND COWPEAS.

BY C. D. SMITH AND F. W. ROBISON.

Bulletin No. 224.

INTRODUCTION.

The appearance of the very timely article on "Bacteria and the Nitrogen Problem" in the year book of the Department of Agriculture for 1902, page 333, and of Bulletin No. 71 of the Bureau of Plant Industry, entitled "Soil Inoculation for Legumes," has placed in the hands of the farmer somewhat full information as to the present knowledge of the significance of nodules on the roots of legumes. It is not the purpose of this bulletin to discuss the micro-organisms involved in the production of these nodules nor to treat of inoculation of seed and soil. That phase of the subject is left to another department of the station. This bulletin is designed to put on record the results of certain investigations made on the station plots, as to the influence of nodules upon the appearance of the growing crops and upon the quantity and quality of the harvest. The bulletin reports progress and not conclusions.

I. THE INFLUENCE OF THE NODULES ON THE ROOTS UPON THE APPEARANCE OF THE PLANTS.

The notes upon the station plots for three years record a great many occasions upon which a very decided difference in color and thrift could be noted between plants in the same plot. Some of the plants would be dark in color and rather more thrifty in general appearance than others. In the case of soy beans where limited areas were thus noted, examinations were made of the roots. In no case could the difference in color be ascribed to the presence of nodules. On a certain series of plots, marked G on the station map, a very conspicuous instance of this kind occurred. A certain area with well defined margins was conspicuous for its dark green color. About it the plants were of a light color. An examination of more than a dozen plants in the dark colored area, failed to disclose the presence of nodules.

A field of soy beans was growing in another part of the station grounds when a similar small area of dark colored leaves was noted. Here, as in the other case, there was no relation between the color and the presence of the nodules. In this case the plants were inoculated but the number of nodules was no greater per plant where the color was dark than where the color was light nor were the nodules larger.

On several occasions equal areas were sown to soy beans and cow peas, one area inoculated and with nodules on the roots, the other area not inoculated. As far as quantity of crop is concerned the results have not shown a large and notable increase due to inoculation.

II. THE INFLUENCE OF THE PRESENCE OF NODULES ON THE COMPOSITION.

On the 23d of September, 1903, there were growing on the station plots, two areas of soy beans. On one of them the roots were practically free from nodules, on the other the roots were well inoculated and nearly covered by them. The variety of beans was the Medium Green, a late sort ripening its

seed but rarely and in favorable seasons only, but affording an abundance of leaves and stems. On the date mentioned, the pods were well formed but the seeds hardly more than well started and much less than half grown.

The seed had been sown in rows eighteen inches apart. From one of the rows, which, in appearance, fairly represented the plot, there was measured off eight feet in length. An area eighteen inches wide, with the row in the middle and eight feet long was left standing while the earth about it was removed to the depth of eight inches. The plants in this eight feet of row were then carefully removed, the dirt being washed away by a gentle stream of water. Each rootlet was thus saved and the entire weight of the plants in the eight feet of row, or twelve square feet of ground, was determined. The total yield of the twelve square feet, including roots, stems and leaves, was then taken to the laboratory, the roots separated from the stems at the point where the mower knife would have cut at harvest and the weights of roots, nodules, and stems and leaves separately taken.

Exactly the same thing was done with a row of soy beans having no nodules. The stems and leaves weighed 5.125 pounds from the area with nodules and 5.562 pounds from the area without nodules. The roots of the beans with nodules weighed but .438 pounds and of those without nodules .625 pounds. The nodules weighed but .16 pounds.

In the early spring of 1904 ground was prepared for a repetition of the work of 1903. After plowing and harrowing two plots were laid off, each a square rod in area. Upon one of them there was applied a wheelbarrow load of soil from a field which had borne soy beans for several years with roots well covered with nodules. The other plot was left without inoculation. As the season advanced, examination showed the roots of the soy beans on the inoculated area to be well covered with nodules while the roots on the area not inoculated remained free from them.

The variety was again the Medium Green. The seed was good and the stand perfect or nearly so. During the growing season no difference was noted in the growth of the two plots, nor in the color of the foliage. The soil was fairly fertile. It had borne sugar beets the year previous and clover the year before that, receiving a coat of barnyard manure upon the clover sod.

On the first of September, eight feet of row was taken from each plot for comparison. As in 1903, the roots were taken for nine inches on each side of the row and to a depth of eight inches. The dirt was carefully removed and all the rootlets and nodules saved. There were 52 plants, weighing 4 lbs. 5 oz. on the eight feet of inoculated row 49 plants weighing 3 lbs. 12 ozs. on the eight feet of uninoculated row. The roots and nodules weighed 9 oz. inoculated and the roots but 6 oz. from the uninoculated plants.

The next table gives the chemical composition of the dry matter of the several parts of the plants mentioned.

COMPOSITION OF DRY MATTER OF SOY BEANS, WITH AND WITHOUT NODULES.

With nodules, leaves and stems.	Ash.	Protein.	Nitrogen.	Phosphoric acid.	Potash.
1903	8.86	18.53	2.97	.55	1.98
1904	8.79	16.23	2.60	.65	2.23
Mean	8.825	17.38	2.785	.60	2.105
Without nodules, leaves and stems.					
1903	8.04	9.56	1.53	.57	1.76
1904	10.25	12.60	2.01	.65	2.17
Mean	9.15	11.08	1.77	.61	1.965

With nodules, roots (nodules removed).					
1903	6.58	6.92	1.11	.35	.87
1904	7.14	5.72	.91	.40	1.29
Mean	6.86	6.32	1.01	.375	1.08
Without nodules, roots.					
1903	4.74	11.31	1.81	.30	.44
1904	12.08	6.60	1.05	.39	1.27
Mean	8.41	8.955	1.43	.345	.855

In 1904 a similar investigation was carried forward with cowpeas. The results are inserted here before comments on the foregoing table are made.

COMPOSITION OF THE DRY MATTER OF COWPEAS WITH AND WITHOUT NODULES ON THE ROOTS.

Leaves and stems.	Ash.	Protein.	Nitrogen.	Phosphoric acid.	Potash.
With nodules	14.39	22.50	3.60	.71	2.47
Without nodules	13.42	15.22	2.43	.84	1.67
Roots.					
With nodules	5.38	5.61	.89	.62	1.32
Without nodules	8.57	12.34	1.97	.61	2.53

COMMENTS ON THE TABLES.

The attention is first directed, naturally to the relative amounts of protein in the forage of the inoculated and not inoculated plants. The leaves and stems together of the inoculated soys carry 17.38 pounds of protein per hundred weight while the not inoculated have but 11.08 pounds per hundred weight as the mean of the two years. Note that in both years the per cent of protein was higher with the inoculated and that when both years are taken together the content of protein was 56.86 per cent greater in the inoculated plants.

With the cowpeas the inoculated plot was 47 per cent richer in protein than the one with plants free from nodules on the roots.

The importance of this fact is apparent. While little difference could be detected between the several plots during the growing season, either in color or general thrift, the chemist found a wide variation in the values of the harvests as to either feeding or manurial constituents. If the presence of the nodules insures no greater yield of these legumes on a fairly fertile soil, if the farmer reaps no heavier harvest where the nodules are, he may expect a richer harvest, better alike for his cattle and his soil.

It is notable that the roots of the uninoculated plot are richer in protein than those of the inoculated. The nodules were removed, of course, from the roots of the inoculated specimens. These nodules have the following composition:—Protein, 26.19 per cent; Nitrogen, 4.19 per cent; Potash, 2.05. The nodules of Cowpeas were analyzed separately and were found to be made up as follows.—Protein, 24 39 per cent; Nitrogen, 3.90 per cent; Phosphoric acid, .96 per cent.

As to why the roots of the uninoculated legumes contain a greater per cent of nitrogen than those of the inoculated, the answer is not obvious. It may be that the material furnished by the germs in the nodules is more quickly carried by osmosis through the cell walls and therefore sooner transferred to the growing parts of the plants.

In the following table there is given the grams of dry matter in the leaves, stems and roots of inoculated and not inoculated soy beans and in inoculated and not inoculated cowpeas. In the columns following there is given the composition of this dry matter in per cents:

COMPOSITION OF DRY MATTER, OF LEAVES, STEMS AND ROOTS.

	Dry matter, grams. %	Protein. %	True proteids. %	Amids. %	Ash. %	Nitrogen. %	Phosphoric acid. %	Potash. %	Yield of nitrogen per acre, lbs.
Soy beans, inoculated.									
Leaves	205.98	22.71	18.44	4.27	11.26	3.63	.72	2.27	113.55
Stems	284.37	11.54	5.81	5.73	7.02	1.85	.60	2.21	
Roots	55.2	5.72	5.23	.47	7.14	.91	.40	1.29	
Not inoculated.									
Leaves	198.92	17.89	13.77	4.12	13.86	2.86	.65	2.29	75.98
Stems	247.48	8.35	5.28	3.07	7.36	1.33	.68	2.07	
Roots	49.00	6.60	5.41	1.19	12.08	1.05	.39	1.27	
Cowpeas, inoculated.									
Leaves	220.61	27.08	22.59	4.49	16.38	4.33	.71	1.63	139.21
Stems	220.21	17.93	11.11	6.82	12.40	2.87	.65	3.32	
Roots	171.15	5.61	4.94	.67	5.38	.89	.62	1.32	
Not inoculated.									
Leaves	238.41	21.52	17.93	....	18.30	3.48	.87	1.20	118.45
Stems	315.44	10.47	....	....	9.73	1.67	.83	2.04	
Roots	62.75	12.34	7.58	....	8.57	1.97	.61	2.53	

The first column, in the above table, reports the weight of the dry matter of the yields of 12 square feet. The weights are given in grams. Because it is unsafe to calculate acre yields from areas so small as 12 square feet, two adjacent plots of soy beans were harvested at about the date of the taking of these samples for analysis. One of these plots contain .8 of an acre, the other 1.29 acres. The former yielded at the rate of 3517.6 lbs. of dry substance per acre and the latter 4214 lbs. Calculating the yields of dry matter per acre from the figures given in the table above we have 3924 lbs. as the yield per acre of dry matter of the inoculated plot and 3572 lbs. for the uninoculated. These amounts are midway between the actual yield of the larger plots. For this reason it is evidently safe to calculate the yield of nitrogen per acre from the factors given in the table. This has been done and in the last column of the table is found the calculated yield of nitrogen per acre expressed in pounds. The yield of the inoculated soy beans is 113.55 lbs. of nitrogen per acre. These figures include not only the leaves, stems and roots as stated in the table but the nitrogen in the nodules on those roots. Unfortunately the weights of the nodules on the roots of the cowpeas was not taken and the 139.21 lbs. includes no nitrogen resident in the abundant nodules.

It is interesting to note that the inoculation has increased the amount of nitrogen in the soy beans almost exactly 50 per cent. It is not yet demonstrated that the 37.57 lbs. of nitrogen found in the inoculated soy beans more than in the uninoculated comes entirely from the air through the intervention of the nodules nor is it known that the 37.57 lbs. measures all of the nitrogen taken in by the inhabitants of these nodules. In any event the increased amount of nitrogen returned to the soil by plowing under a crop of inoculated soy beans is amply sufficient to induce every farmer to see that his crop is inoculated if he intends to use it as a soil renovator.

The fact that the per cent of protein is so much greater in both leaves and stems of inoculated soy beans must lead to the determination to inoculate the crop if it is to be cured as hay. It is worthy of note that in the soy beans the increase in protein is mostly in the true proteids and not in the amids. The inoculation does not seem to notably affect the phosphoric acid nor the potash.

What has been said of the soy bean is true of the cowpea. Here, however, the difference in yield of protein per acre is not so wide and significant.

III. THE INFLUENCE OF THE PRESENCE OF NODULES UPON THE COMPOSITION OF THE SEED OF SOY BEANS.

In 1904 some investigations were conducted to test the influence of the nodules on the roots on the composition of the ripened seed of two varieties of soy beans. The Medium Green is not certain to mature its seed in this latitude, but did so in 1904. The Ogemaw is an earlier sort, fairly certain to ripen in an average year. Seed was gathered from each of four plots, two inoculated and two not inoculated and were submitted to the chemist for analysis. The results are set forth in the next table.

Ogemaw.	Moisture, per cent.	Protein, per cent.	True proteids, per cent.	Fats, per cent.	Fiber, per cent.	Other carbohydrates, per cent.	Ash, per cent
Not inoculated	8.08	35.39	22.69	15.66	5.18	30.52	5.17
Inoculated	8.88	42.20	31.28	13.36	5.20	26.13	4.23
Medium green.							
Not inoculated	8.12	31.23	21.46	17.38	5.92	32.22	5.13
Inoculated	8.80	36.45	24.51	16.27	5.40	27.96	5.12

FERTILIZER VALUE.

Ogemaw.	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Not inoculated	5.66	1.72	2.09
Inoculated	6.75	1.43	1.56
Medium green.			
Not inoculated	5.00	1.78	2.38
Inoculated	5.83	1.66	2.43

The influence of the nodules had not spent itself on the growing plant, but carried itself throughout the period of growth, making the ripened seeds of the inoculated soy beans fully 16% richer in protein than the product of uninoculated areas.

Whether this increase in protein content will give greater vitality to the seeds affected or cause the growth of a more vigorous crop the next season remains to be investigated.

In conclusion of the work of the two years it has been learned that the nodules on the roots, while, on fairly fertile soil, they may not notably increase the yield, do increase the relative and absolute amount of nitrogen in the plants. This increase is very important and pronounced.

ALFALFA IN MICHIGAN.

C. D. SMITH.

Bulletin No. 225.

INTRODUCTION.

There were discussions concerning the value of alfalfa to Michigan farmers as early as 1888, when the crop was editorially recommended for trial, especially on the lighter soils of central Michigan and on worn lands in the southern part of the State. Not much was written on the topic, however, and there were few successes recorded. Some correspondents in Eaton, Lenawee and Oakland counties reported trials but usually the winters were found too hard for the crops as they were then handled.

On the other hand the rural press for the last five years has been full of reports of trials of alfalfa under all kinds of conditions, some correspondents reporting success, others failure. Clover has failed occasionally and there has been an earnest effort to secure another forage crop richer still in protein. Alfalfa has succeeded in western United States and has yielded abundant crops of hay rich in protein and very palatable. It is therefore to be expected that it should be extensivly tested in Michigan.

The first mention of alfalfa in the publications of the station occurs in the report of Professor Samuel Johnson, Agriculturist, in 1889, page 271 of the Annual Report of the Secretary, 1889. Professor Johnson says: "Plat 2 (one acre) was sown with twenty pounds of alfalfa seed. This came up in one week from the date of sowing and continued to grow, and June 9 covered the ground fairly well. The highest plants were four inches above the ground and the roots extended more than this below the surface. A frost on the night of June 1 injured the alfalfa to quite an extent. The alfalfa was dark green, and until affected by the drouth in July when it turned yellow, made a fair growth; although some of it seemed dead, the roots were not affected and later in the season it revived and made a fair growth. The alfalfa feeds mainly from the subsoil, and for this reason many fail to get as good results as they look for. It thrives best on an old soil, that which has received deep thorough tilling for some years." The farther history of the field is not given beyond the fact that the crop did not withstand the winter.

On each succeeding year, small fields of alfalfa have been sown on the college farm or the station plots, studying the adaptation of alfalfa to Michigan conditions. In 1893 and 1894 special efforts were made to bring this forage crop into prominence because the depredations of the root borer had made the successful growing of clover impossible.

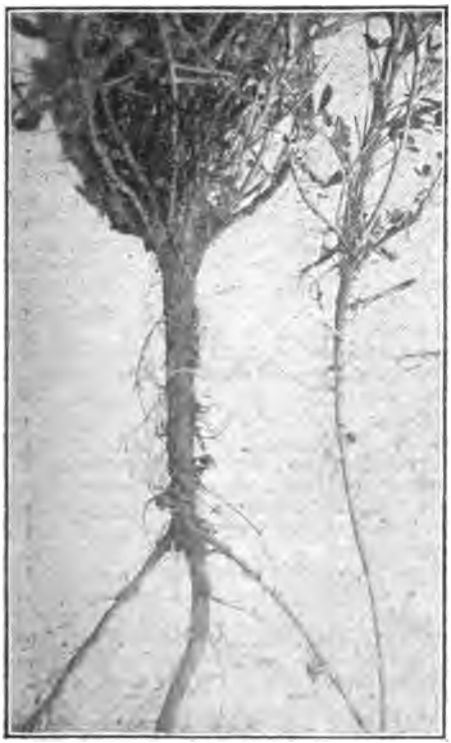
Early in the year 1894 the station issued a brief press bulletin in which alfalfa was recommended for further trial and at the close of the same year Bulletin 125 was issued giving facts in regard to alfalfa with the preliminary statement as to the kind of soil on which it might be expected to do best, and directions for sowing and caring for the growing crop. In 1896 Bulletin 141 was sent out in which the history of alfalfa in Michigan for that year was recounted.

A two acre field on the south bank of the Red Cedar River was sown to alfalfa in 1895. The soil varied from a stiff clay to a light coarse sand of low fertility. The seed was purchased in the open market and was said to be fresh and American grown. It was sown on well prepared ground at the rate of 20 pounds of seed per acre, in May. The crop survived the winter in good shape and four cuttings were made in 1896, May 28, June 29, August 17 and September 26. The total yield of dry hay per acre was 9,937 pounds. After the last cutting the alfalfa made a good growth and the field was green and very promising. In the spring of 1897, however, not a living alfalfa root could be found on the entire two acres. Although the winter was not extraordinarily severe, and although the field was fairly well covered with snow the destruction of the alfalfa seemed to be complete.

In 1897, not discouraged by former reverses, farther sowings of alfalfa were made. On some very light sand some seed of the variety called sand lucerne was sown. A good catch was secured. The yields of this acre in successive years were as follows: In 1898, 6,800 pounds; 1899, 10,000 pounds; 1900, pastured; 1901, 13,839 pounds; 1902, 12,034 pounds; 1903, 5,820 pounds.

The plot was plowed up in the spring of 1904, June grass having crowded the alfalfa so far that few plants were left.

In the years between 1897 and 1901, alfalfa was sown both on the strip reserved for new and peculiar plants, called the "Curiosity Strip" and on other parts of the station grounds. It was observed that in nearly every case, on a majority of the plants, nodules were present. In no case was artificial inoculation used, nor was



Alfalfa roots showing normal nodules, small and near large roots.

Peculiar nodules on Alfalfa roots, in groups and distant from large roots, on small rootlets.

soil brought from a former alfalfa field to the new plot. It is possible that the germs were carried on the seed or were already resident in the soil. In 1897, for instance, a plot of alfalfa was sown on a distant field, number 14 of the college farm, fully a half mile from any other alfalfa or from any plot that had borne alfalfa for many years, yet the roots were found to be well inoculated and have remained so until date, 1905. In 1904 some clean seed was sown on an area in field 6. In 1903 the field had borne vetches. The crop was not gathered but was allowed to lie on the ground during the winter to be plowed under in the spring of 1904, shortly before the alfalfa was sown. The accompanying cut shows the abundance of the nodules and their peculiar grouping. No artificial inoculation of either seed or soil was used.

A study of the work accomplished with alfalfa and the lessons to be drawn from the many tests on the station plots is reported in this bulletin.

SUMMARY.

I. Alfalfa belongs to the family of legumes, along with clover, peas and beans and therefore may entertain on its roots micro-organisms which have the power of converting the nitrogen of the air into forms which plants can use. For this reason it would be a valuable addition to the list of forage plants in Michigan if it should prove hardy and capable of withstanding the severe winters.

II. The leaves and stems of alfalfa are very rich in protein. The average protein content of the hay gathered in May, June and August was 14.48 per cent, while that of clover hay is not far from 12 per cent. Alfalfa furnishes a first crop ready to harvest, on ordniary seasons, the last of May. Two other crops usually follow, the second in July and the third in late August. For this reason it makes an excellent soiling crop. The yields of dry hay per acre on good soil vary from three to six tons.

III. Alfalfa is peculiarly adapted to arid sections under irrigation. Whether it will become a permanent and valuable crop for Michigan is yet to be determined. It has met with little or no success in New England outside of Vermont, where, out of fifty-six trials, fourteen farmers report failure, twelve permanent success and ten temporary success. In Quebec, Ontario and New York it has succeeded at several points.

IV. The station has distributed alfalfa seed for trial to over one hundred and fifty farmers. The United States government has also distributed seed to many farmers in the State and the records of these plots have been turned over to this station. Of seventy-six reports from farmers who have tried alfalfa, thirty-two record absolute failures, due generally to winter killing; twenty-four record partial success, for a single year; sixteen record success for two or more consecutive years. The chief enemies of the crop in Michigan, after winter killing, are June grass, and dodder. The latter is a parasitic plant introduced with the seed. No alfalfa seed should be sown until approved by the station.

V. Alfalfa seed is expensive and the temptation to adulteration is therefore strong. No seed should be sown until its per cent of germination is determined. The Turkestan variety has given less yields than others, but has withstood the winters better. As between the so-called Salauer seed from Utah and Colorado grown, there seems to be but little difference. The variety called sand lucern seems to withstand the winter as well as Turkestan and to give larger yields.

VI. Alfalfa has been sown on all kinds of soil on the station plots and seems to do equally well on the light sand and on well drained clay. It does not do well on undrained land, on soil with a stiff subsoil near the surface, on acid soils nor on muck of the kind on the station grounds.

VII. Alfalfa responds to fertilizers whether barnyard manure or commercial fertilizers. Of the latter those containing lime, phosphoric acid and potash, without nitrogen, seem to be called for.

VIII. The repeated sowings at the college have scarcely recorded an instance where the roots have been free from nodules although no artificial inoculation has been used. The germs giving nitrogen-fixing power seem to have been transferred to the new crop on the seed.

From some parts of the State reports come that nodules are not present. It is therefore prudent to inoculate the seed or soil with the proper germs when sowing.

IX. Prudence dictates that twenty pounds of seed per acre should be used providing the per cent of germination is above eighty. If the seed has a lower per cent of germination, even larger quantities per acre should be sown.

X. The date of sowing depends on the season, the month of May being preferred, in southern Michigan, and possibly the month of August north of the line marking the southern boundary of a permanent snow cover during the winter.

XI. If weeds threaten the tender plants in the first season they should be clipped but the last clipping should not be later than the last week in August.

XII. Although large crops are secured where the alfalfa makes a good stand, hard winters are certain and the crop is not yet entirely beyond the experimental stage in Michigan.

THE INVESTIGATIONS.

SOILS.

Alfalfa has been tried on many varieties of soil from the light blowing sand to the heavy plastic clay and on muck. On the latter the stand has been neither good nor permanent, the crop usually dying off within two years from winter killing combined with injury from frosts. The adaptability to muck has not been sufficiently studied to warrant a final statement. Experiments are now in progress to answer questions on this topic.

On stiff clay the crop made a good growth in 1895 and 1896 but was totally destroyed in the winter of 1896-7. The roots were not short, notwithstanding the stiffness of the clay but extended for distances of five to eight feet into the subsoil, where plenty of water was found.

On a dry gravel bank, alfalfa has made a stand from 1897 to 1905 and is still vigorous although the stand is not thick enough for a profitable crop. A deep excavation has been made at one side of the plot and the roots of the alfalfa discovered at a depth of fourteen feet below the surface, the roots being at that point one-fourth inch in diameter.

On loams of all kinds, some almost pure sand and others approaching the clay, alfalfa has almost invariably made a good start. Severe winters have killed off the plots in almost every case, but loams seem to be the types of soil on which the crop does the best.

On sands that are carried by the wind which therefore are lacking in adhesion and in humus, alfalfa seems to be rather more permanent than elsewhere. Plots sown on such soil in 1897 produced good crops until 1903. It cannot be said therefore that alfalfa is a crop unusually fastidious in the matter of soil. It is true that stagnant water near the surface is fatal. It is probable that a very stiff and impenetrable hardpan within a foot or two of the surface might make success impossible, but the station records give no notes on the latter point. Because of its long tap root, alfalfa seems especially adapted to a deep soil with the water table distant from the surface. The root hairs on slender rootlets are to be found to a depth of several feet showing that the plant takes its food from layers of the soil below the reach of the cereals. This fact may partly account for the success on light sands.

PREPARATION.

It has been assumed that the crop with which we are dealing does not differ from spring grain in demanding a suitable seed bed, hence it has been the invariable custom to sow the seed on ground plowed to a good depth, but not deep enough to bring up a cold and unaired subsoil, well harrowed and rolled to break up lumps. To compact the surface soil to establish capillary connection with the subsoil is, of course, essential.

The influence of the previous crop on the growth of alfalfa has been observed, although the data is not sufficient to warrant definite statements. Where alfalfa has succeeded itself after four years of cropping the new seeding has made a very slow growth, possibly by reason of the exhaustion of the potash and phosphoric acid. Where alfalfa has followed vetches a peculiar segregation of the nodules was noted as has already been stated, page 137. So far other crops seem to have been neutral in their effects on the succeeding alfalfa.

Experiments have been undertaken to note the influence of various fertilizers. None of the college soils are acid yet lime is invariably applied before the seed is sown. On one series of plots a strip was sown to air-slaked lime and the next to the lime cake from a sugar factory. The crop is the same over the two plots showing absolutely no difference between them. The application of nitrate of soda did not seem to either hasten the growth or increase its magnitude. In another case the nitrate gave a visibly darker color to the alfalfa than did an excess of either phosphate or potash, but the growth of the young plants is no more rapid where the nitrate is applied than elsewhere. An examination of the roots showed a larger number of nodules on the plot to which phosphoric acid was applied and the nodules were larger.

METHODS OF SOWING.

In the earlier work the seed was sown in rows 18 inches apart and cultivated. The results were entirely satisfactory, although the plots were too small to make the record of yield valuable. Where it is desired to be sure of a catch, the method is to be recommended. Under usual field conditions the seed might better be sown broadcast because, if rain follows when the crop is cut, it is difficult to cure on the raw ground. The wheelbarrow seeder or some similar appliance may be used. A harrow follows, burying the seed to a depth of half an inch. If a nurse crop is used the seeder may be put in front of the grain drill when the hoes of the drill will cover the seed fully deep enough. Some correspondents recommend this method but it has not been tested at the station.

A nurse crop is not recommended. If the season should turn out to be one with the rain well distributed it is possible that the nurse crop will not only do no harm but will help the alfalfa. In 1903, an area sixteen rods north and south by fourteen rods east and west was sown to alfalfa in strips one rod wide, the strips running east and west. The question of a nurse crop was here studied. Plot 9 had 15 pounds of American grown seed per acre, sown April 18 after oats had been drilled at the rate of one bushel per acre. Plot 16 was treated in the same way except that 20 pounds of seed was used. Plot 9 had the oats removed as they began to head out, while plot 16 carried the oats to maturity. The season was a wet one and the oats lodged badly. All plots stood the winter well and were cut three times in 1904, on June 7, July 11, and August 30. The results of a comparison of the plots bearing a nurse crop with adjacent plots having none do not show an injury from the nurse crop. Plot 9 with a nurse crop gave a total yield of 641 pounds of dry hay, while plot 8 gave 574 pounds and plot 10, 664 pounds, neither having a nurse crop. Plot 16 with a nurse crop yielded 696 pounds of dry hay, plot 15 without, also 696 pounds. It must not be forgotten that the rainfall in 1903 was evenly distributed through the growing months and the nurse crop did not have the usual effect of reducing the amount of moisture in the soil below a sufficient supply for the alfalfa.

AMOUNT OF SEED.

A comparison of two quantities of seed was made on the station plots. On the 18th of April, 1903, two plots were sown at the rate of fifteen pounds per acre and two at the rate of twenty pounds. In the spring of 1904 the stand was equally good on all four plots. The yield of hay was practically the same where fifteen pounds were sown as where twenty were used. The season of 1903 had the rainfall distributed all through the season and there was no drouth. Where the seed has a high per cent of germination, where the ground is well prepared and well fertilized and where the rainfall is so distributed as to leave no drouth during the season, fifteen pounds of seed is evidently enough; but since no man can foresee what the season will be, it is wise to sow twenty pounds.

VARIETIES.

The varieties tested has been American grown, locality unknown, Colorado, Utah, Sand Lucern, and Turkestan furnished by the Department of Agriculture at Washington. The American grown seed was purchased in the open market. Its color was good and the seed perfect in brightness and freedom from dodder and other weed seeds. The Colorado was also a good sample, clean, bright, and free from impurities. The Sand Lucern was not free from weed seed nor had it as good color or as bright appearance as the American. The Turkestan was somewhat peculiar in color but was a fair sample.

No great difference in appearance of the crops was noted in 1903. The seed was sown on April 18 and 21. On May 30 it was noted that there was a good stand, the American grown rather taking the lead. On June 8, June 29, July 20, and August 7, the plots were clipped, the guards of the mower set six inches high. Naturally the clippings were left on the ground.

On the fourteenth of September it was noted that the Sand Lucern was not as high as the Colorado or American grown. The Turkestan was notably small.

The observations in 1904 began April 21. The alfalfa was growing nicely on all plots and with some poor spots on the plots with American grown seed. The

Utah had a good stand without poor spots. The same was true of the Colorado. The Turkestan in one plot was poor, in the other fairly good. It was farther noted on the fourth of May that the Sand Lucern was making a rather more rapid growth than the other varieties.

On the eleventh of May, after a hard frost on the night of the tenth, the alfalfa drooped but soon straightened up and showed no permanent injury. There were hard frosts on the fifteenth and sixteenth of the month. The alfalfa leaves turned yellow on the edges and some of them shriveled up and dropped but the plants soon recovered. The crop was cut June 7, July 11, and August 30. The plots were one rod wide and fourteen rods long. There were sixteen plots in the experiment altogether, numbered consecutively from the north to the south. The whole area was lacking in homogeneity and it was necessary to separate the plots of each variety that the comparison might be fair. The following table records the height of the alfalfa on the date of the cutting and the weight of dry hay on each plot:

Plot.	Variety.	Seed per acre, lbs.	Sown, 1903, April	June 7.		July 11.		August 30.		Total hay, lbs.	Yield per acre, lbs.
				Height, ins.	Hay, lbs.	Height, ins.	Hay, lbs.	Height, ins.	Hay, lbs.		
2.	Salauer (Utah).......	20	21	22.5	288	20.3	222	12.8	135	645	
10.	Salauer (Utah).......	20	18	22.5	287	19.1	244	13.2	133	664	7,480
3.	Colorado.............	20	21	23.0	200	18.7	214	11.3	121	535	
11.	Colorado.............	20	18	22.5	301	19.7	262	14.7	150	713	7,131
4.	Sand Lucern..........	20	21	21.0	252	18.5	195	11.0	105	552	
12.	Sand Lucern..........	20	18	22.5	266	19.3	228	13.9	120	614	6,663
5.	Turkestan............	20	21	20.5	320	18.2	162	12.0	83	475	
13	Turkestan............	20	18	21.5	258	18.6	198	12.8	107	563	5,931
15.	American grown......	20	18	24.0	298	19.6	235	16.1	163	696	
1.	American grown......	20	21	22.5	280	19.2	171	13.2	135	586	7,326

These are the yields of a single season and do not represent conclusions as to the relative values of these varieties.

In the spring of 1905 the Sand Lucern and Turkestan plots are quite notably better than the others. Plot 15 was badly winter killed while plot 13, Turkestan, maintains an almost perfect stand. Plot 3, Colorado seed, is visibly poorer than 4, Sand Lucern, or 5, Turkestan. A glance at the heights of the plots on August 30 does not indicate that up to that date the Turkestan alfalfa was much shorter than the other varieties, but after the last cutting it seemed to recover more slowly and was much shorter throughout the rest of the season. In the late fall it was the least promising of any of the varieties tested, but in the spring of 1905 it gives evidence of greater hardiness than its competitors. It did not yield as much as the Sand Lucern and much less than any of the American varieties. Which of the many kinds of alfalfa shall be finally selected for general use in the State is an open question.

LATE CLIPPINGS.

In 1904 the season was wet after the last cutting, August 30. There was, consequently, a tall and fairly thick after-growth. By the seventh of October this after-growth was fully knee high. The question then arose whether for the sake of the crop in 1905, this growth ought to be clipped. To test the matter the west half of all plots was clipped, using the mower with the guards set as high as possible. The clippings were left as a mulch. They were not thick enough to smother the plants.

At the date of this writing (May 10, 1905) it is very evident that the clipping was a serious injury to the field, since, although the ground is poorer where the clipping was not done, the alfalfa is taller, stronger and a better stand.

COMPOSITION OF THE THREE CUTTINGS.

Samples of the harvests of June 7, July 11 and August 30 were taken for analysis with the following results:

	Ash. per cent.	Total protein, per cent.	True proteids, per cent.
June 7	10.39	14.39	8.60
July 11	10.00	14.57	8.78
August 30	8.91	16.57	2.02

The small per cent of true proteids in the third cutting is very significant as it is to the true proteids, not to the amids that the total protein owes its feeding value. The hay from the third cutting ought to have less feeding value than that from either of the earlier harvests of the year, notwithstanding its apparent greater richness in total protein.

HARVESTING.

The harvesting of the crop has not presented unusual difficulty. The first cutting, coming as it does early in June is rather difficult to cure because full of juice and the weather usually wet. Here is the place where hay caps are called for and are used at the station. They are not expensive and will last, with reasonable care, for many years. The alfalfa is cut after the dew is off on a bright day, stirred up with a tedder or a side delivery rake, left in loose windrow until the dew begins to fall in the late afternoon when it is piled up into rather large heaps and covered with hay cap. The hay is then allowed to sweat, is shaken out carefully to prevent loss of leaves, is allowed to dry as other hay and hauled to the barn with as little handling as possible and in a condition rather more moist than is usual with clover hay. The danger of hauling too green is that spontaneous combustion may result as is shown by investigations in Kansas. At this station no bad results have followed hauling alfalfa hay when in the tough stage, where it may be twisted into a rope. The danger of allowing the hay to become too dry is that the leaves are lost and the leaves are the part of the plant richest in protein.

EXPERIENCE OF MICHIGAN FARMERS.

The Experiment Station has distributed small quantities of alfalfa seed to a large number of farmers and has repeated the distribution for two or three consecutive years. Seed has also been obtained by enterprising farmers from other sources and experiments have been widely scattered over the State. In 1904 and 1905 the farmers have reported their success to the station. Extracts from some of these letters will be of interest and value. Of seventy-six reports, thirty-two record failures, twenty-four record partial success for a single year and sixteen cases where the alfalfa had lived at least two years.

The failures are ascribed to many causes, chief among which were the severe winters of 1902-3 and 1903-4. In these cases the damage seems to have been done by coats of ice in the spring rather than by extreme cold weather. It is significant that alfalfa seems to do well in the upper peninsula where the thermometer falls lower than in the southern peninsula, but where there is a certainty of a good cover of snow from early fall to late spring, though even here it is seriously if not fatally injured by the winter.

In Special Bulletin No. 31, Superintendent Geismar of the Upper Peninsula substation, says: "The yield of the alfalfa plots has increased each year and the large yield of the past season shows that the plants are now fully established and that this valuable crop is well adapted to Upper Peninsula conditions." A later report from the substation, written in April, 1905, since the snow has left the ground, shows that the plants are nearly killed. There was a good coat of snow over the ground all winter and the injury to the plants is not easily accounted for unless the dense covering with a hard crust for part of the winter be

the cause. The fact remains, however, that even under conditions as favorable as those surrounding the plots at Chatham, alfalfa is still in the list of crops to be experimented with rather than among the established certainties.

It does not seem to have been difficult to secure a stand, but either the drouth or the winter kills the crop when established.

A. H. Foster, Allegan, reported in December, 1904, that four acres of alfalfa sown at the rate of 20 lbs. per acre in the spring of 1903, was winter killed, the German seed standing the winter rather better than American grown, and that a field of common red clover sown in winter wheat beside the alfalfa lived through the winter almost perfectly.

F. L. Church, of Antrim County, reports the sowing of sand lucern furnished him by the college in 1903. He sowed part of the seed alone and part of it with Telephone peas. Where sown alone it was so weedy that he mowed it on the fifth of July. The patch did not grow much afterward. In mid-summer of 1904 the alfalfa sown with the peas was better than where sown alone. One-eighth of an acre sown in the peas in 1903 yielded at the first cutting of 1904, 286 lbs., or 2,288 lbs. of dry hay per acre.

C. C. McDermid, Calhoun County, reports that he sowed alfalfa May 1, 1901, at the rate of 16 lbs. per acre, which was lightly covered. One-half was Turkestan and one-half was sand lucerne. He could see no difference in the plants as they grew side by side. "Both have made a moderate growth each year since (April 19, 1905), have never seriously winter killed, and are looking well now, but are too thin on the ground for best results."

"They have never yielded a profitable crop of hay, the clover alongside beating them more than three to one. The crop last year was better than ever before, probably the result of gradual soil inoculation with the alfalfa bacteria from some unknown source. The plants, or some of them, now have small nodules on the roots like those on red clover in size and general appearance."

"My field is high and well drained, soil mixed sand and clay loam; good garden soil."

Alexander Watson, of Dowagiac, writes that he has an eight acre field of alfalfa standing through six years and looking sound in the spring of 1905. He says: "I have never used my field for anything but a pasture field, but it is great for that. In all these years it has never killed out in any way, neither winter nor summer. All the original planting is still there. My land is sandy with a hard pan within a few feet of the surface."

H. C. Hatch, of Dowagiac, writes: "I sowed my alfalfa August 22, 1899. It stands the winter all right. I cannot do without it now, although I have always pastured it. I shall sow ten acres more this fall (1905)."

Earl W. Durfee, of Litchfield, writes: "In May, 1902, I sowed sixteen acres to alfalfa. It started as nice as a person could ask. No weeds grew on the piece to choke it out, but it kept getting thinner and thinner. I was so in hopes that it would come on that I left it. I clipped it every year, but never cut any of it for hay till last year, when I mowed about half of the piece and the other half I have plowed up this spring. In some parts of the piece that I have left the alfalfa is nice, in other parts it amounts to almost nothing."

"In 1903 I sowed twenty acres of alfalfa. This came up very nice also. The following winter was very severe and the most if it winter killed. I plowed it up a year ago this spring. Alfalfa has been quite extensively sown in this vicinity, but it did not do well and the most of it has been plowed up. I know of only one piece, a neighbor has three acres, which was sown three years ago"

Dennis Miller, Eaton Rapids, writes: "My experience with alfalfa has not been very successful. I sowed two acres, using 25 lbs. of seed to the acre, about May 25, 1903. The ground had been plowed early in spring and worked frequently before sowing the seed. It was a good stand in 1904, with the exception of a touch of the yellows along in August. In the spring of 1905 I find that it is all winter killed, with the exception of about a half acre lying next the woods. The soil is sandy with a little clay."

W. B. Williams, of Charlotte, writes, under date of April 9, 1904: "Some fifteen years ago a friend gave me a few quarts of alfalfa seed with directions for sowing. I must not sow oats or any other crop with it. I had a small piece, about a third of an acre, sandy loam. I manured it thoroughly, and sowed the seed. The alfalfa did not make much show the first year. The second year there were fewer weeds and more alfalfa. The third year I mowed it three times, and this

I continued to do for many years. I think it was in its prime the fourth year. The first crop of the season was always the heaviest, the second, six weeks later, a little lighter, and the third was quite light, though it paid for cutting. I think I kept it some eight or ten years. Frequently in the spring the roots were so few and scattering it seemed to have failed, but in a few weeks it would come on quite thick. It did not show much sign of dying out until I allowed a man to stake his cow on it for pasture. When I plowed it up I found roots five and six feet long, although it was not hard to exterminate. I am inclined to think it would do well on the sandy pine lands. I have my doubts whether it will stand pasturing."

In Huron County two correspondents tried alfalfa for two consecutive years, but in both cases it was killed by a hard winter.

Three correspondents in Jackson County report attempts to grow alfalfa, but winter killing has prevented success. In one case the alfalfa survived for several years, but is now extinct.

J. B. Duncan & Son, of Vicksburg, write under date of April 13, 1905: "On a few spots in our piece of alfalfa it appears to have been partly killed out during the winter. The amount of loss will probably be about 20 per cent. The parts not killed are now looking well and we hope will make a fair crop. The nodules are just beginning to appear on the roots. The seed was inoculated by cultures obtained from the Department of Agriculture at Washington and was sown last year."

In Lapeer County it was tried on muck, sandy loam and clay loam, but in each case it was a failure. Another man had had reasonably good success with it for several years.

In Lenawee County, alfalfa wintered well on some pieces while on others it was killed in the winter of either 1903-4 or 1904-5. A. J. Allen, from Clinton, writes, May 20, 1904: 'Alfalfa is pretty well killed, as are clover and wheat, except near the fences and in low places where there was a covering of snow. In 1899 I had some alfalfa frozen to death also. Last year I had twenty-two acres, all on clay. It was cut three times and yielded from two to five tons per acre. I believe it would do well on any soil if the water is not too near the surface of the ground."

"I have had good success in seeding on corn stubble, if enough dirt can be scratched up to cover the seed. That is all that is necessary. It has caught and done as well this way as where the ground has been plowed in the fall and subsoiled. I believe it is the best feeding crop that can be raised on the farm if the killing winters do not come too often. I used a side delivery rake and hay loader. Last year I put in some alfalfa under circumstances where red clover would have spoiled. The alfalfa came out in good condition. I filled a silo six feet in diameter from the last cuting for chickens. It kept well. There was no waste. It seemed to dry out a little, but did not spoil."

A farmer near Tipton notes that June grass is the worst enemy of alfalfa in that section, with the possible exception of the hard winters.

Concerning the experience of farmers about Tecumseh with alfalfa, Mr. J. R. Keeney, of Tecumseh, gives important testimony, writing in May, 1905. He has two acres of alfalfa, cut three times in 1904 and twelve inches high in places on the 7th of May, 1905. He reports that Mr. Howard, of Tecumseh, has a small field looking fine. Mr. William H. Osborne, of Tecumseh, has cut a certain field for several successive years. This field has plenty of nodules. It is along the road where there is plenty of sweet clover, to which plant the inoculation may be due. Mr. Abner Wilson, of Tecumseh, has five acres sown in 1904 with inoculated seed. No nodules yet discovered. R. D. Harrison, of Tipton, has ten acres which look fine. William Fisher has five acres near Tecumseh, now in excellent condition. John T. Clark, of Clinton, has grown ten to thirty acres for years with success. His Turkestan alfalfa has plenty of nodules. Charles Clark of Clinton has a large field which is in excellent condition, sown last season and yielding a crop of hay the season when sown.

Mr. Keeney states that there are many other fields about Clinton which have withstood the winter successfully and are in good condition now. There is so much sweet clover in the vicinity, especially along the highway, that he is inclined to think the soil is well inoculated. He has known of no failures where the alfalfa has had a chance.

This testimony, combined with what precedes and follows, seems to indicate that alfalfa is a very promising crop for Lenawee County.

C. A. Jewell, of Hudson, reports his experience briefly, as follows. Two experimental fields were sown in the spring of 1903. One was a strip across a corn field, rolling and uneven, the soil varying from light sand to heavy clay. The seed was sown without a nurse crop early in the spring. A heavy rainstorm came on, on the day of sowing, preventing harrowing and making the stand very uneven. The second field was an old pasture cut off from the farm by a railroad. It had not had manure for years. It was plowed early and frequently harrowed until after corn planting, when the ground was in perfect tilth. Twenty pounds of seed was sown per acre after two barrels of air slaked lime per acre had been applied. The seed came up quickly, thickly and evenly, and made a very rapid growth. "Following the orthodox teaching, I clipped it with a mowing machine, I think three times, whenever the heads began to blossom, running the mowing machine four inches high, cutting off the plants mostly below the leaves and checking the root growth every time. A few handfuls of alfalfa seed being left, it was mixed with red clover and timothy and sown on the small, irregular shaped patch outside of this acre. It was not handy to mow and was left to take care of itself throughout the season. The winter following, 1903-4, was the severest in some ways ever known in this section. A thick sheet of ice lay upon the earth through December, entirely destroying the red clover and injuring the alfalfa very badly, killing it all in the hollows and at least half the plants in other parts, except the little patch not clipped, which was entirely uninjured, every plant seemingly alive, though all the clover amongst it was killed. I shall never clip alfalfa the first season again."

Alfalfa has been tried in Manistee county and in other sections of the State in that latitude. It has not done very well notwithstanding the fact that the ground is usually covered with a good coat of snow. Reports from Mecosta county indicate that the same statement is true for that region.

From Newaygo county the reports are quite discouraging. One farmer near Fremont reports success for a single year while others agree in condemning alfalfa when grown under present methods.

In the upper peninsula, besides the reports from the State Station at Chatham, there are letters from Menominee county showing that the crop is doing well there. Ira Carley of Ingalls reports that he has one and a half acres of alfalfa which was sown with oats in 1903. Three crops were cut in 1904 on June 19, July 24 and August 28, the last crop being the best. The hay is fed to all kinds of animals including hogs, which do well on it. He also sowed a field in 1904 which survived the winter in good shape and both fields are promising in the spring of 1905.

From the letters and official reports from the upper peninsula it is safe to draw the conclusion that alfalfa is a safe crop to experiment with north of the straits and that there is reasonable assurance that it will become a leading forage crop for as much of the upper peninsula as has good soil and a certainty of a continuous cover of snow during the winter.

In Oakland county alfalfa has been tried a great many years. Mr. C. W. Bennett of Milford sowed one-half acre of alfala twelve years ago on rich, well drained clay loam. It has been cut two and sometimes three times each year since, furnishing good yields of hay. The June grass is crowding out the crop to such an extent that the field will be plowed this year. Mr. Harper Gardner of Oxford has a small field which has been mowed three times a year for six years. The alfalfa hay has proven invaluable. Fred M. Daines of Farmington reports success with alfalfa both for hay and pasture. He recommends the crop for situations where the field is to be permanently seeded.

Perhaps the man who has had the longest and most successful experience in Oakland county is A. D. De Garmo of Highland. He writes under date of March 29, 1904: "I have sown a little alfalfa seed nearly every year for twenty years to see what it was like and to learn if it would withstand our winters, and conclude that it is as hardy as our June clover. Neither will stand severe cold after being pastured short, on our light soil. At one time I had thirty acres of alfalfa and the same amount of red clover. I pastured this field one season; then came the hard cold winter of six or eight years ago and killed the whole area, both clover and alfalfa.

Some six years ago I sowed one and one-quarter acres of alfalfa on the first of June at the rate of twenty pounds of seed per acre. The field is a sandy loam near the barn and was in good tilth. The seed germinated readily and grew

nicely for a time until the drouth came. We had no rain all summer hence the alfalfa only attained a height of four to ten inches. Few weeds grew and these were pulled out by hand. The alfalfa was not cut the first season.

The following spring that alfalfa grew first and faster than any other crop on the farm, rye not excepted. On June 1st we cut three good loads of nice hay. Forty days later we cut two large loads of hay. The plot was cut again, about the last of August but was not raked. The following year the alfalfa patch produced about the same sort of crop. The third year it was pastured. The low temperature of the following winter with the ground bare killed half of the plants."

In Wayne county a correspondent writes from Belleville under date of April 3, 1905, that he sowed ten acres to alfalfa in 1903, rolling and top dressing with fine manure. He secured a fine catch; ran the mower over it twice in 1903. The next winter killed nearly all of it.

Mr. George C. Peterhans of Plymouth reports that in 1903 he seeded a plot of ground at the rate of sixteen pounds per acre, but regrets that he did not apply twenty pounds. On the tenth of April, 1905, the crop was in fine condition. He had a good crop of hay in 1903, cutting it in September.

Mr. Fred Rocker, also near Belleville, cut thirty tons of alfalfa hay from ten acres of sandy soil in one season and then pastured seventeen head of cattle on the meadow all the fall after cutting this hay. As a result he found the alfalfa in bad condition in the spring of 1904. N. A. Clapp of Northville reports on April 1, 1905, that the field of alfalfa of which he was proud in 1904 was entirely destroyed by the winter.

William H. Bailey of Hart, in Oceana county, reports good success with alfalfa after five years' experience. He finds the worst enemy to be the June grass.

Mr. P. B. Reynolds of Shiawassee county reports that he sowed an acre at the rate of twenty pounds of seed and secured a good stand, but the crop was entirely destroyed by the winter.

It is impossible to print all the letters received concerning this crop, but enough has been given to show the present condition of alfalfa in the State and the attitude of the farmers toward it. Perhaps the most significant fact brought out by the correspondence has been that winters are a serious menace. Alfalfa is peculiarly a crop to be left in somewhat permanent possession of a field. It requires two seasons at least to secure the needed root development. It is undoubtedly true that thereafter it will draw a large per cent of its plant food from strata below the reach of the roots of the cereals. It is illy adapted to a short rotation. It is an expensive crop to start. For all these reasons the winter-killing is a serious matter. It is to be hoped that strains of the most promising varieties will be developed which will become as thoroughly acclimated as clover and timothy and better able to endure Michigan winters.

THE WORK AT THE SUB-STATIONS.

Review of Special Bulletins 27 and 30, Reports of South Haven Sub-station for 1903 and 1904, by L. R. Taft.

Review of Special Bulletins 28 and 31, Reports of the Upper Peninsula Sub-station for 1903 and 1904, by C. D. Smith.

SPECIAL BULLETINS 27 AND 30.

Reports of South Haven Sub-station for 1903 and 1904.

[Bulletin 226.]

BY L. R. TAFT.

The report of the South Haven Sub-station for 1903 was issued in April, 1904, as Special Bulletin No. 27. It is devoted largely to notes upon new varieties of orchard and bush fruits which have given one or more crops. It includes red and black raspberries, blackberries, currants, grapes, gooseberries, cherries, plums, peaches, pears, apples, quinces and nuts. Lists of the standard sorts that have been thoroughly tested and found desirable are also given. Special attention is also paid to the conditions, climatic and otherwise, under which the various fruits were grown.

The report of the sub-station for 1904 was printed in April, 1905, as Special Bulletin No. 30. This is a continuation of the work included in the report for 1903.

The following are among the varieties that received favorable mention: Strawberries, Aroma, Brandywine, Clyde, Dunlap, Ernie, Excelsior, Lincoln, Glen Mary, Sample and Seaford. Raspberries, blackcaps, Eureka, Cumberland, Kansas; red varieties, Cuthbert, Early King, Marlboro, Miller and Phoenix. Gooseberries, Downing, Josselyn and Pearl, of the American, and Columbus, Keepsake and Chautauqua of the European kinds. Currants, Red Dutch, Wilder, London, Cherry and Fay as red varieties; White Dutch and Black Naples are also desirable kinds. Grapes, Moores, Campbell, Ohio, Worden and Concord, black; Diamond, Niagara and Pocklington, white; Delaware, Vergennes and Brighton as red sorts. Cherries, Dyehouse, Richmond, Montmorency and Montreuil of the sour varieties; and Napoleon, Windsor, Plymouth and Governor Wood of the sweet sorts. Peaches, Triumph, Brunson, Oceana, Longhurst and Gold Drop were among the more hardy kinds; of the promising new sorts, Dewey, Banner, Carman, Emma, Hieley, Welch and Worth are highly spoken of; Michigan, St. John, Champion, Engle, Elberta, Kalamazoo, New Prolific, McCollister and Salway are among the best of the standard sorts. Plums, Red June, Abundance, Burbank and Satsuma of the Japan varieties; Bradshaw, Lombard, Fellenberg, Arch Duke, Black Diamond, Grand Duke, Bavay and Monarch of the European sorts are well-known and profitable kinds for home use or market; Shropshire and French Damson plums are generally very productive and bring the highest price. Pears, Clapp, Bartlett, Flemish, Howell, Angouleme (Duchess), Seckel, Clairgeau, Dana Hovey, Kieffer, Lawrence and Winter Nelis are among the surest and best sorts. Notes are also given upon nearly eighty varieties of apples. Among the new or little known sorts, especial mention is made of Boiken, Newby, Sutton Beauty, Fanny, McIntosh, Ontario and Hubbardston. In the bulletins referred to, full descriptions are given of the above named sorts as well as several hundred others, many of which are of much merit.

In addition to the notes upon the varieties under trial, especial attention is given to the results obtained in a series of spraying experiments in which careful tests upon a variety of fruits were made of several dust sprays, soda-bordeaux

and a variety of mixtures for the control of the San Jose scale in addition to the ordinary insecticides and fungicides. In brief, none of the dust sprays give as good results as the liquid sprays except perhaps against the plum curculio. They had little effect in controlling the curl-leaf of the peach or the scab of the apple and in the case of varieties that are subject to the attack of these diseases, the injury where the dust mixtures were used were so great as to practically cause the loss of the crop.

Soda-bordeaux, although not nearly as valuable as the ordinary lime mixture, answers a good purpose in controlling fungous diseases late in the season when the lime mixture would be likely to discolor the fruit.

Of the remedies for the San Jose scale, nothing was more effective than the ordinary sulphur, lime and salt mixture, using 25 pounds of lime, 15 pounds of sulphur and 8 pounds of salt for 50 gallons of water. Practically as good results, however, were secured when no salt was used, and in preparing small quantities, when the heat from the slaking lime was utilized for boiling the mixture. As the scale has not obtained a lodgment in the station orchards, the various mixtures were tested in three orchards in other parts of the county on peach and apple trees. Excellent results were obtained in the case of the peach trees in all places, as, at the end of the season, the infested trees were practically free of the scale indicating that when the work is thoroughly done this destructive insect can be controlled upon peach trees by spraying them once in two years. As the sulphur and lime mixture is also a remedy for leaf-curl and to some extent for the rot, annual applications can generally be made with profit in orchards where the scale has appeared.

A test was also made of the use of caustic soda as a remedy for the scale. When used at the rate of six pounds in 50 gallons of water it proved of little value, as a sufficient number of the scale survived to encrust the trees at the end of the season even worse than they were at the beginning. One serious objection to the use of this solution is its caustic effect upon the face and hands of the operators, and especially if it reaches the eyes. It has, however, been used at even greater strength than the above, the amount in several cases ranging from 12 to 25 pounds of caustic soda in 50 gallons of water. These strong solutions not only destroyed the scale, but freed the trees of their rough bark and gave them a fresh, glossy appearance.

The results obtained when spraying apple trees for San Jose scale were less satisfactory than with the peach, and most other fruits, as the trees are generally not only larger and with thicker heads than other fruit trees, thus making them more difficult to spray, but the loose and rough bark upon the trunks and larger branches make it almost impossible to reach all of the scale, and the same is true regarding the fuzzy covering upon young twigs of many varieties. For these reasons the results ordinarily secured when spraying apple trees have not been as good as with the peach, especially from the first one or two applications.

The results from various experiments with cover crops, both at the South Haven Station and cooperative, are given in both of the bulletins. Of the leguminous crops which are of especial value for supplying nitrogen, winter vetch, mammoth clover and crimson clover have been valuable in the order named. Cow peas and soy beans are of no value unless they can be sown as early as the first of July under favorable conditions. Considered only as cover crops, barley has been most satisfactory, having larger leaves and stouter stalks than oats. Field peas have been used with both of these crops with good success.

As fifteen years have elapsed since the location of the sub-station at South Haven, the following brief notes regarding the station and its work may be of interest. Previous to that time experimental work in horticulture had been carried on at the Agricultural College, but as the location and climate is less favorable for fruit growing than in many sections along the shore of Lake Michigan, and in other important fruit regions in Michigan, it was felt that this interest merited more attention than could be given the College orchards and the State Board of Agriculture authorized the location of a sub-station in the "Peach Belt," at some point where the work of the station could be observed by fruit growers and where they could also obtain results that would be more reliable than those secured in the College orchards.

For a number of years the Hon. T. T. Lyon, at that time President of the State Horticultural Society, had under trial upon his premises at South Haven, a large collection of tree and bush fruits that were just coming into bearing.

Mr. Lyon owned ten acres of land within the limits of the city of South Haven and within a few hundred feet of the shore of Lake Michigan. In the spring of 1889, arrangements were made with him for a report upon the varieties under test upon his grounds, but as it was thought best to place it upon a more permanent basis, a lease was obtained the following spring of the land belonging to Mr. Lyon, and through his efforts and those of the Hon. C. J. Monroe, the five-acre tract adjoining the Lyon land on the south was purchased by some of the public spirited fruit growers of the section and presented to the State Board of Agriculture to be used as an experiment station. The following year Mr. Lyon erected a dwelling for his own use upon his land and also put up a convenient stable, packing-house and office building. The land was thoroughly under-drained and surrounded by a wire fence and a hedge of Japan quince. The soil is a light sandy loam underlaid at the depth of one or two feet with stiff clay.

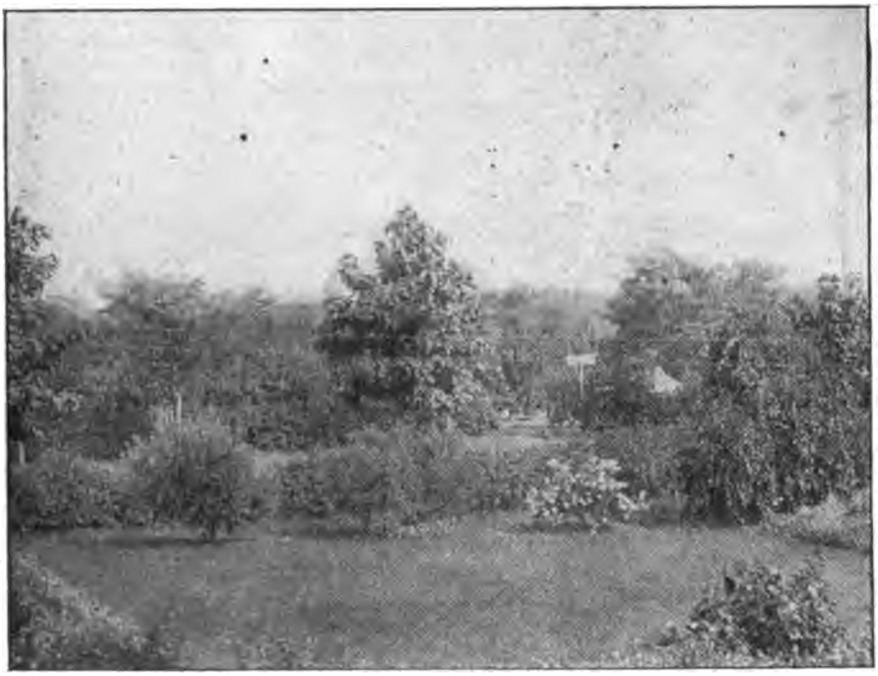


FIG. 2.—Lawn and Shrubbery. South Haven Sub-Station.

Aside from a small area about the buildings which was planted with shrubbery, the entire tract was devoted to fruit. Nearly two hundred varieties of peaches and grapes and from one hundred to one hundred and fifty kinds of apples, pears, plums and cherries have been planted besides quinces, apricots, nectarines and nut trees of various kinds. Plantings were also made of the standard and new varieties of currants, gooseberries, raspberries, blackberries and strawberries.

In addition to careful notes upon the different varieties of fruits as they matured, a large amount of experimental work has been done in other lines, among which may be mentioned, first, spraying experiments which embraced the testing of various insecticides and fungicides, including the strength that should be used, the number of applications and the date they should be applied. Various spraying apparatus has been secured and tested and reports have been issued from time to time.

Second, tests of different fertilizing materials for orchards and small fruit plantations. While the requirements for different soils vary, it is evident from

FIG. 3.—Pear Tree With Low Head.

experiments carried on at the sub-station and from cooperative work done at various points in that section that there are few bearing orchards upon which potash and phosphoric acid cannot be used to advantage. These elements can be secured respectively in muriate of potash, and acid phosphate or ground bone, although where it can be obtained at not to exceed six dollars per ton unleached hardwood ashes would be found more economical. Especially upon light soils and where the trees have produced several crops of fruit, nitrogen has also been found lacking. While it can be obtained from stable manure and leguminous cover crops, these sources are not always available and recourse may then be had to nitrate of soda.

Third, considerable attention has also been paid to cultivation and cover crops for orchards. As the soil is of a sandy nature and mulching material difficult to obtain, the orchards have been kept in thorough cultivation up to the middle of July or the first of August, and a very satisfactory growth has been secured. As continued cultivation soon results in the removal of the humus from the soil, it has been customary for the past ten years to make use of some form of winter cover crop. The results with these have been briefly summarized above.

Fourth, pruning and training. Various methods of pruning and training the different kinds of fruit have been tested. The best results have been secured where the trees have been grown with rather short trunks, ranging from one foot in the case of dwarf pears, sweet cherries and peaches, to about two and one-half feet in the case of apple trees. When trained with high heads, there has not only been much greater injury from the cracking of the trunks, especially of cherry and peach trees, but the pruning and spraying, as well as the thinning and gathering of the fruit, have been found to be much more difficult than when

FIG. 4.—View in the Peach Orchard. Showing Effect of Heading Back.

grown with short trunks. For several years the new growth, especially of peach trees and of others that naturally formed open heads, was cut back about one-half. After that the heading in was confined to preserving the symmetry of the trees, except in the case of peaches where the leading shoots were cut back, occasionally even below the growth of the previous year. In order to lessen the injury from rot and other fungous diseases, as well as to heighten the color of the fruit, the trees were grown with fairly open heads.

In pruning the bush fruits, the new growth of blackberries and black raspberries was cut back to the height of two to three feet according to the varieties, but the red varieties were not headed back except perhaps in the case of a few kinds that branch naturally. No other pruning during the summer is given except to remove the old canes, but the following spring just before growth starts, all surplus shoots are removed and the branches are cut back to a length of about one foot.

FIG. 5.—Grapes on Horizontal Arm Trellis.

The pruning of currants and gooseberries is done in the spring. It consists in the heading back of the new growth and the removal of the older plants as well as the weaker new ones, the idea being to leave four or five old and one or two new canes. Various trellises have also been used for training the grapes. A vertical trellis with two No. 10 wires at a height of three and four and one-half feet, respectively, from the ground has been most satisfactory, although a trellis with horizontal arms bearing three wires has given good results.

As indicated above, Mr. T. T. Lyon took charge of the sub-station in the spring of 1890 and continued to act as superintendent until 1899 when failing health made it necessary for him to give up the work. He continued, however, to occupy his residence until the time of his death which occurred in March, 1900. During the ten years in which Mr. Lyon was in charge of the sub-station he issued annual reports giving the notes taken upon the different varieties as they came into bearing and the results secured from the cultural operations.

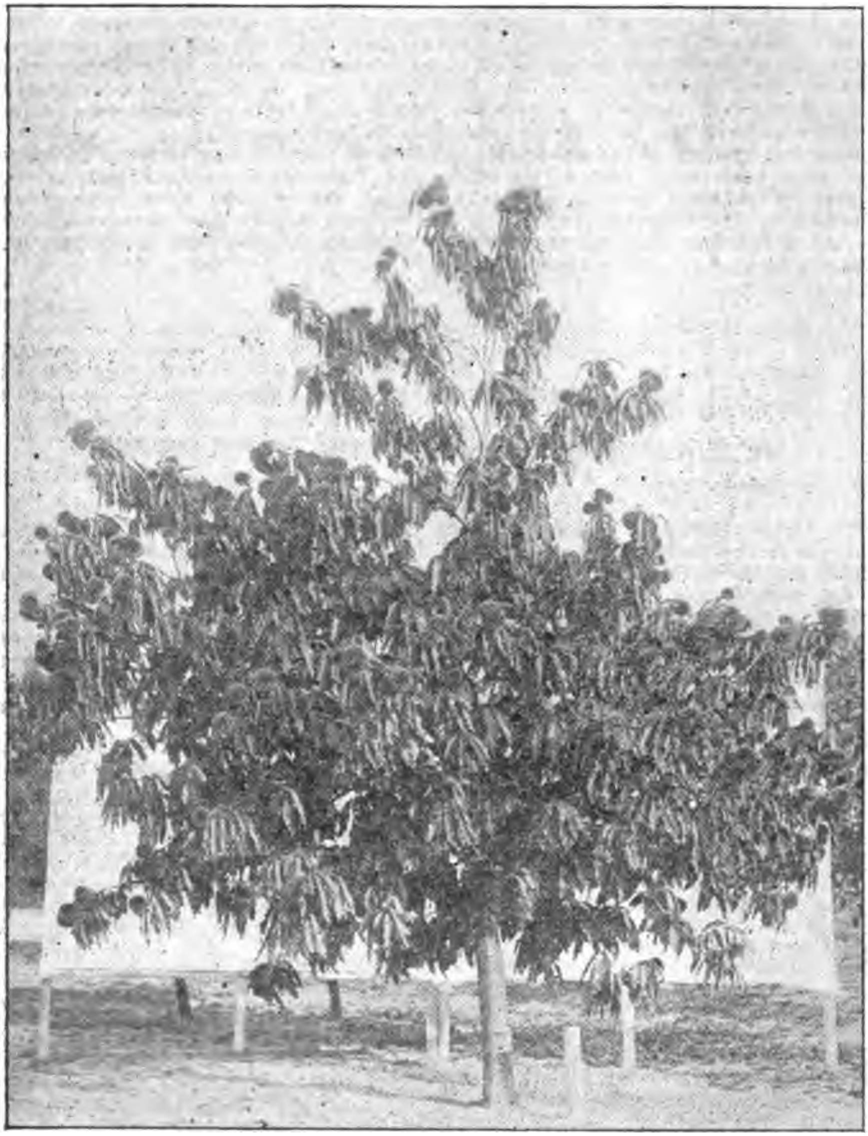


FIG. 6.—Paragon Chestnut in Fruit

Upon the retirement of Mr. Lyon the charge of the sub-station was given to Mr. S. H. Fulton who had made a specialty of horticulture while a student at the Michigan Agricultural College and, after graduating, spent two seasons in some of the largest nurseries and orchards in the state of New York. In November, 1901, Mr. Fulton resigned to become horticulturist of the Georgia Experiment Station. He was succeeded by Mr. T. A. Farrand who had spent one year as a foreman with Mr. Fulton and thus had become somewhat familiar with the methods employed.

In addition to the work carried on at the sub-station and in the several co-operative experiments conducted in that section, the superintendents have, when their other duties permitted, responded to invitations to inspect orchards in the vicinity, where dangerous insects or diseases have appeared and advise regarding the remedies that should be employed. The advice thus given, as well as suggestions for handling the orchards, has been found very valuable, especially as several hundred fruit farms in Van Buren county have been purchased by Chicago parties who have had little or no experience in fruit growing.

From the opening of the sub-station exhibits of the different varieties of fruits have been made each year at the State and West Michigan fairs and, as the number of varieties in bearing has increased, the exhibits have become correspondingly larger until the number of varieties shown has in recent years reached about four hundred that were in condition at the time of holding the fairs.

SPECIAL BULLETINS NOS. 28 AND 31.

Reports of the Upper Peninsula Sub-station for 1903 and 1904.

C. D. SMITH.

The Upper Peninsula Sub-station was created by an act of the legislature approved in the early spring of 1899. By the terms of that act $5,000 was appropriated for the purchase of a suitable tract of land in the Upper Peninsula and for the maintenance of the sub-station for two years. Late in July of that year the State Board of Agriculture, to which board the control the sub-station was delegated by the law, located the site at Chatham, in Alger county, and accepted a donation of 160 acres of land immediately north and west of the railroad station, viz.: the S. E. one-quarter of Section 28, Range 46 North, 21 West. Chatham is eight miles due south of Au Train Bay on the south shore of Lake Superior and from 250 to 300 feet above its level.

When accepted, the farm was covered with a heavy growth of hardwood timber, principally maple, and was in the center of a large tract of hardwood covering several townships with few clearings, none larger than a dozen acres.

The donors of the farm agreed to clear, brush and stump forty acres and to remove the timber from the next forty but they partially failed to fulfil their agreement, contenting themselves with clearing something like seventeen acres. The State Board has, as a consequence, been obligd to go to the expense of clearing the land needed for the station plots. By the autumn of 1904 when Special Bulletin No. 31 was written, nearly forty acres had been cleared, with all stumps and stones removed.

The valley of the Slap Nick Creek, running, with high banks, from east to west, cuts the farm in two. The flood plain of the creek overflowing each spring and remaining too wet to work, takes up fully five acres of the cleared area. On both sides of the flood plain are alternately banks too steep to work and fairly level terraces upon which the plots are laid out. The clearing began on the entire east line of the farm and has extended westward forty rods.

Over most of the cleared portion the soil is thin, seldom exceeding three feet in depth. The northern third of the cleared portion has a deeper soil, in places fully fifteen feet deep. The underlying rock is a very calciferous sand stone. The soil is a dark colored sandy loam with abundant humus.

A house and barn have been erected on a terrace north of the creek. The fields have been fenced with wire fencing at no inconsiderable expense as many of the post holes had to be blasted in the rock.

The funds expended in the years ending on the dates mentioned are as follows:

June 30, 1901	$4,257 64
" 30, 1902	2,501 55
" 30, 1903	3,269 93
" 30, 1904	4,402 87

CLIMATE.

The climate of the Upper Peninsula is distinguished from that of the Lower Peninsula by the greater depth of snow in winter and by the fact that the covering of snow is both certain and continuous. The ground seldom freezes at this sub-station. Potatoes may safely be planted in the fall with the certainty that they will not be frozen during the winter. The summer rainfall as compared with that at the Michigan Agricultural College in the following table:

	1900		1901		1902		1903		1904	
	College	Chatham	College	Chatham	College	Chatham	College	Chatham	College	Chatham
May	4.17	....	2.36	3.72	4.71	2.11	2.63	4.12	2.40	6.34
June	2.57	....	3.57	4.10	7.28	3.32	6.28	1.71	2.49	3.31
July	4.15	3.23	5.08	5.32	7.13	3.53	3.79	6.64	1.97	2.28
August	2.98	3.12	2.49	1.67	.78	3.42	6.73	5.93	3.26	3.07
September	.87	3.83	1.67	5.23	5.88	2.21	2.86	3.34	2.35	4.32
October	2.77	....	4.61	5.24	1.53	3.70	2.01	3.34	1.90	1.29
			19.78	25.28	27.31	18.29	24.30	25.08	14.37	20.61

CEREALS.

Wheat. The plots devoted to variety tests of the various cereals are too small to make the results more than suggestive.

Fall wheat has been grown with good success on clay soils in practically all parts of the Upper Peninsula, in the earlier work at the sub-station, Dawson's Golden Chaff rather leading the other varieties in hardiness and abundance of yield. The late frost blackens but does not kill the wheat. In 1903 plant lice seriously injured the crop and shortened the yield. In 1904 the close covering of snow seemed to smother the plants in winter, killing some varieties entirely. The Dawson lived through but the stand was poor. The indications from the small plots are that fall wheat is a crop to be recommended to Upper Peninsula farmers although wet harvests and plant lice are certain and hostile factors.

Spring wheat. Owing to the short seasons and cold weather during the summer, spring wheat does but fairly, the yield being from 12 to 20 bushels per acre. The velvet chaff seems to be the type of spring wheat of most value.

Oats. Early ripening varieties such as the Early Champion and University No 6 should be selected as rust is bad on later sorts. The abundant rainfall causes a splendid growth of both straw and grain but it favors the growth of rust as well. No variety is rust proof no matter what its name may be and the only safeguard against the ravages of the disease is earliness of ripening.

Barley. Beardless sorts do well in the Upper Peninsula generally, and gave a good account of themselves at the station, the Champion being the best variety. Manchuri is another sort with a good record. Barley will be grown chiefly for feed in the Upper Peninsula to take the place of corn. The color of the grain is not, therefore, as important a matter as it would be farther south where barley is grown for malting. Barley thrives as far north as northern Norway in Europe and seems to be pre-eminently the cereal for northern latitudes.

Speltz or *Emmer* appears in every way like wheat except that the grain retains about it, at threshing, the glume which surrounded it. While growing it resembles wheat so closely as not to be distinguished from it. It is used for stock food, either threshed or in the straw and demands farther trial on a larger scale.

Corn. Extended experiments have been made with corn for several years. In no case has it ripened. The whole effort of the station is directed toward the selection of early varieties and strains of varieties which will ripen under the adverse conditions existing in a section of country where frost comes very late in the spring and very early in the fall. It is possible that the clearing of larger areas and the cultivation of more fields may so modify the climate as to permit corn to ripen with some degree of certainty. At present barley must be depended

on for the supply of grain to take the place occupied by shelled corn in latitudes farther south. Corn itself will be grown for fodder and for silage.

FORAGE CROPS.

The grasses. Timothy is undoubtedly the leading grass in the Upper Peninsula as it is in the rest of the State, largely because it is hardy and because the period in which it can be cut for hay is long. While orchard grass must be cut as soon as it comes in blossom or the hay will be woody and unpalatable, timothy may be cut at any time after the heads are fully formed and before the seed hardens with the certainty that it will make fairly good hay. Again, timothy, while not making the best hay, is fairly certain in its yield, a statement which cannot be made of other grasses. Orchard grass has done well upon the station plots and is to be commended to the attention of Upper Peninsula farmers. Meadow fescue demands a moist climate. It is a leading grass in England. Conditions at the Upper Peninsula station seem to favor it as a hay grass. Meadow foxtail is worthy of further trial as a pasture grass because of its earliness. Bromus inermis which does so well in the west, seems to find in the Upper Peninsula a place that suits it. Kentucky blue grass, the universal pasture grass, also commends itself to the Upper Peninsula farmer. The trials of these grasses at the experiment station warrant these statements.

The *millets* have made tremendous growths whenever sown since the establishment of the station. They will mature in a short season and although they are easily killed by the frosts they grow so rapidly that a good harvest may be expected when they are sown in May, or even as late as the first of June. When sown the fourth of June the Hungarian millet was harvested the third of September, yielding nearly four tons to the acre. Sown again June 8, 1904, it was harvested September 14, yielding something over three tons per acre The fact that the plots at the station are exceedingly small must be kept in mind in considering these yields.

Legumes. The leading legume, as far as the extent of tests at the station is concerned, is alfalfa. This plant has been sown for several years at the station and has lived through the winter undoubtedly because of the certainty and sufficiency of the snow cover. In other parts of the Upper Peninsula alfalfa has lived through the winter and the areas of the alfalfa fields are increasing. Wherever it has been sown where a hardpan is near the surface or where sown with a nurse crop failures are reported. Again, the small size of the plots prevents the report of reliable data in the comparison of different varieties of alfalfa or of crops growing from seed from definite sources. The German alfalfa or the crop from imported seed seems to have done as well at the station as the American grown seed. The Turkestan gives the smallest yield of any of the alfalfas tried in the year 1904.

In the spring of 1905 it was noted that the crowns of the alfalfa seem to have been smothered out in the winter and the roots are sending up new shoots from below the crown. This makes the stand apparently very thin and heavy crops cannot be expected.

A European legume called Sanfoin gives some promise after three or four years trial.

June Clover. It has not required the work of the experiment station to show that on all clay loams and clays of the Upper Peninsula June clover is very certain to yield a heavy crop. Alsike clover belongs to the same list. The climate and soil are of the type which the clovers demand. The sole drawback seems to be the wet harvests.

Certain other legumes like the chick pea will require a good deal of observation before they are recommended. The lupines, both white and blue, make a luxuriant growth and display a hardiness almost equal to clover. The cow peas did not get far enough along to blossom. The soy beans were planted June 7 and blossomed August 7, setting a large number of pods with beans in various stages of growth. None approached ripeness. In 1903 the Ito San and the Ogemaw blossomed as early as August 22 and although no seed ripened, still the pods were well filled. Several other varieties of soy beans grew to a height of 30 inches to 36 inches, but did not ripen seed.

The vetches did not ripen seed and hence there seems to be little danger of the plant becoming a weed in the Upper Peninsula. In 1904 they were still in

blossom at the beginning of November and some vines had reached a height of 12 feet. Superintendent Geismar recommends the plant as a weed destroyer.

Lathyrus ochrus was planted June first in 1903 and ripened late in August.

MISCELLANEOUS CROPS.

Buckwheat has ripened on successive years and is a safe crop for the Upper Peninsula. It is a little difficult to handle at harvest time because of adverse weather.

Field peas make an enormous growth, sometimes 11 to 13 feet. The work of the station is directed toward securing varieties that give an early harvest with a less growth of vines.

Flax ripens its seed and there is no reason evident why the Upper Peninsula should not in time produce an abundance of this crop for seed and for fiber.

The station has developed the plan of planting potatoes in the fall, relying upon the continuous covering of deep snow to protect the seed from freezing. No great advantage in yield is found by adopting this method but the crop is considerably earlier. Level culture is practiced. Of the varieties of potatoes the Sir Walter Raleigh has, on the whole, proved the best.

Sugar beets have made good yields in the several consecutive years and the per cent of sugar has been high. A sugar factory has been erected at Menominee and the station has investigated the possibility of growing beets in the middle or northern parts of the peninsula. No reason is apparent why beets of high sugar content should not be produced on all of the clay loams of that peninsula.

Carrots, rutabagas, mangolds, table beets, all reach perfection at the Upper Peninsula Station in quality and in yield. The crops at Chatham are not surpassed in any part of the State.

GARDEN VEGETABLES.

A dozen varieties of snap and string beans were tried in 1904, all of them ripening and none of them suffering from disease.

Sweet corn reached the edible stage but did not ripen. Many varieties of cucumbers planted in the early spring were killed by a frost on September 22 in 1904. They had grown, however, a good crop of pickles prior to that time. Tomatoes did not ripen though the vines reached a good height and were heavily loaded with fruit when killed by the frost of September 22. Cabbage developed good hard heads and gave a very satisfactory yield. Onions were practically destroyed by maggots in 1904, that pest having spread rapidly over some parts of the Upper Peninsula.

A host of other garden vegetables and miscellaneous ornamental and useful crops were tested in the two years but results of importance have not yet been reached.

Strawberries have been grown since the station was started. The standard kinds ripen their fruit in great abundance at the station, even though the environment has not been altogether favorable. The late frosts have been the worst enemy.

THE ORCHARD.

Apples. Russian varieties have been tested. Seven varieties ripened fruit in 1904, the Haas, Borovinka, Gideon, Hibernal, Patten Greening, Yellow Transparent and Duchess. High winds have been not uncommon and have done considerable damage to the trees. Spraying has kept back the apple scab and good care has secured a good growth. The winters are severe. The trees are not damaged below the snow line, but above that, many varieties are injured on the south side, evidently from the bright sun reflected over the snow. This damage occurs in late December or early January or at any period in the winter when zero weather and high temperature sharply succeed each other. Some varieties like the Mann, Wagener, Boskoop and Canada Red were seriously damaged.

In 1904 most of the varieties of grapes made a growth of six or eight feet, but the fruit, although colored, failed to ripen properly.

Cherry trees are particularly susceptible to the damage from high winds and the late frosts. A disease is also attacking some of them below the surface

of the ground where the scion was grafted into the root. The tops and the roots seemed to be fairly healthy but there was a zone of dead bark and dead tissue surrounding this junction of graft and root. The cause and nature of this disease has not been determined.

It seems to be fairly well determined from the investigations thus far carried on at the station, that the sour cherries, the hardier pears and the Russian apples may be grown with comparative certainty in the Upper Peninsula and that that section of the State will not be deprived of fruit of its own growing. Peaches are, of course, excluded, while plums are injured by the deep snow and the high winds. All sorts of root crops and nearly all garden vegetables common to the southern peninsula do well in the central part of the Upper Peninsula. Of the field crops corn must be dropped from the list for this region, while fall wheat will be grown at great risk. It is safe to say in conclusion that the possible crops for the northern part of Michigan constitute so large a list that the farmer will have no difficulty in securing a profitable and satisfactory rotation.

Mr. Leo M. Geismar has been the able superintendent of the sub-station since its beginning. He has not contented himself with the planning and carrying forward of experiments of great value, but has exercised a dominant influence on the upbuilding of agriculture in the Upper Peninsula by lectures at meetings of farmers and by frequent, valuable and inspiring contributions to the rural press.

LEGUMES OTHER THAN ALFALFA.

C. D. SMITH.

[Bulletin 227.]

Summary.

1. Of the multitude of leguminous plants of economic importance, the following were tried on small plots: White lupines, sand lupines, gorse, sweet clover, fenugrec, kidney vetch, goat's rue, Astragalus sinensis, seradella, sulla, sanfoin, peanuts, goobers, giant beggar weed, Japan clover, Cicer arietinum, lentils, lathyrus and the vetches.

Of this list the following indicated some value as green manures, especially on sandy soils: the lupines, kidney vetch, goat's rue, crimson clover and the vetches, while the following gave some promise as a food supply for stock: crimson clover, seradella, sanfoin and Japan clover. For various reasons the following indicated no value for Michigan: sweet clover, fenugrec, *Astragalus sinensis*, sulla, peanuts, goobers, *Cicer arietinum*, lentils.

2. Tests carried on since the publication of a former bulletin confirmed the opinion that lathryus silvestris is of little value either as a fodder plant or for green manure.

3. Among the varieties of cowpeas, these are recommended for such Michigan farmers as need them to plow under to enrich the soil in nitrogen: the Iron, the New Era, Whippoorwill and Blackeye. They must be planted late in the spring when the ground is fairly warm as they do not grow well in cool weather. They do not develop ripe seed except in unusually warm seasons, with frosts late in the fall.

4. Soy beans are now grown in all parts of Michigan. The tests discriminate between varieties designed to produce abundant forage and those bred to produce abundant seed. Of the former the medium green, early black, and yellow are leading sorts, of the latter the Ogemau, the rather small Ito San, and govern-

ment 9413 are good types. The plots were too small to make the experiments, comparing varieties, of great weight

5. The hairy vetch has been grown at the station for a good many years. It has been used as a green manure and as a forage crop. It has not been a success in the latter capacity. Sheep were hurdled on the vetch but would not eat it. It was then tried as a soiling crop but neither cattle nor sheep seem fond of it. It was cured as hay but again the stock refused it.

There are sold in the markets a great many species of vetch seed under the name of winter vetch, hairy vetch or villous vetch. The results of a comparative trials of these vetches at the station show that at least eight of them produce but a small amount of green forage, although they ripen abundant seed. Of these the *Vicia picta* was a fair sample, flowering in early July and fruiting in the middle of August.

On the other hand the *V. canadensis*, *angustifolia* and *peregrina* were three vetches that yielded abundant foliage and fewer seed. *V. disperma* showed relatively few seeds but a great quantity of matted leaves and stems, supplying a dense mass of succulent green. Finally the *biennis*, the Louisiana vetch, the *gerardii* and *globosa* have showy, red or blue flowers and furnish a tangled and heavy mass of green forage. The horse bean, as the *V. faba* is generally called, is totally unsuited to Michigan climate, although of great value in England.

Professor B. O. Longyear suggests an analytical key which may aid in properly locating a new vetch.

Farmers are warned that the vetch has become a weed difficult to exterminate on the College farm and elsewhere.

6. Small areas of medium green soys, Ogemaw soys, New Era cowpeas, the *Vicia globosa*, second crop June clover and new seeding June clover were dug about and the soil washed away leaving the roots attached to the stems They were separated into roots and forage at approximately the point where the knife or the mower would havé cut at harvest and were separately weighed and analyzed. Combining the different factors and estimating the normal yield of forage per acre, it was found that the medium green soy yielded 152.29 pounds of nitrogen per acre, the cowpeas 61.90 pounds, the vetch 77.10 pounds, the second crop clover 51.47 pounds and the new seeding clover 49.06 pounds.

A later experiment in which soy beans and cowpeas were sown side by side to compare their values as green manure with that of buckwheat, the yields indicated a rather greater value to the soy beans as the analyses given above would suggest.

THE EXPERIMENTS.

In 1903, under the supervision of Mr. Bronson Barlow, now of the Ontario Agricultural College, Guelph, Ontario, an extended series of observations was made on a long list of legumes, some of them common and others rare, to determine which should be selected for farther investigation. Naturally most of these legumes are but illy adapted to Michigan conditions but it was decided to test them all that some information might be gained. The report is given in Mr. Barlow's language.

Lupinus albus, Linn., White Lupine. Planted May 15th, flowers July 1st to July 18th, fruit July 21st, fruit ripe and stems leafless August 19th, 36 inches high July 22d. It grows rapidly and produces a large bulk of green matter to be plowed under on sandy ground. It may be fed before coming into bloom. It has not been injured by blister beetle this season.

Lupinus termis, Forsk., received from Cairo, Egypt. Planted June 12th, grew well and was 16 inches high July 22d, 34 inches high August 19th, in full bloom August 19th, fruit matured slowly but some seed ripened in the fall. It is an attractive plant and compares well with L albus. Its season is longer and for seed it should be planted by the middle of May.

Ulex, Linn., Gorse. Planted May 15th, 12 inches high August 19th, no flowers this first year, promises to endure the winter, has grown slowly, but is thrifty. It is a shrubby plant with spiny leaves. In Wales horses are often kept through the winter on Gorse. In England the farmers use it for fuel and for building rough shelters for sheep and cattle. For this purpose they cut it and tie it into fagots.

Lupinus arboreus, Linn., Sand Lupine. Planted June 12th, grew slowly, 4 inches high July 22d, 12 inches high August 19th, flowers yellow August 19th

to September 27th, fruit formed slowly and some seed matured. This lupine did not thrive. It seems to have been too wet.

Trifolium incarnatum, Linn., Crimson Clover. Crimson clover, planted May 15th, flowers and fruit by August 19th and until September 27th, 12 inches high July 22d, 20 to 24 inches high August 19th, affected with a fungous disease, remains green under the snow.

It is said that in the mountains of West Virginia they sow crimson clover when they cultivate the corn ground for the last time in summer, and the next spring plow under the crimson clover before planting corn again. By this method they raise corn every year and still maintain the fertility of the soil.

Melilotus alba, Desr., Sweet Clover. The young plants were transplanted to this plot June 20th. By August 19th they were 36 inches high, and bushy. They did not bloom and died down to the ground in fall. Sweet clover is a troublesome weed along roadsides.

Trigonella foenum-greacum, Linn., Fenugrec. Planted May 15th, flowers June 21st to August, fruit is ripe July 22d, mostly dead August 19th, seed germinated in pods September 25th and the young plants grew until snowed under. The seed is used in condition powders. It is not of value as a forage plant in Michigan.

Anthyllis vulneraria, Linn., Kidney Vetch. Planted July 7th, 1 inch high August 19th, no flowers. It grew slowly as it does the first year. It may be tried on soil too sandy and barren for clover.

Galega officinalis, Linn., Goat's Rue. Planted May 15th, flowers July 24th to September 27th, fruit September 27th, 14 inches high July 22d, 24 inches high August 19th. Remaining green below under the snow. It will grow in sand and it resists drought. We have better plants for the better class of our soils. Stock has to learn to like it.

Astragalus sinensis, Early variety, Japan. Planted May 15th, 4 inches high July 27th, 4 inches high August 19th, dying. A dwarf, densely tufted plant. It did not thrive but declined and died. The roots did not appear normal.

Astragalus sinensis. Late variety, Japan. Notes as for the above, a few violet red flowers in threes at the summit of scape-like peduncles appeared late in July then plants declined and died.

Ornithropus sativus, Brot., Seradella. Planted July 7th, up July 20th, 2 inches high August 19th, first flower September 27th. No fruit. This should be planted in May, it grew well in the fall but had not time enough. It remains green under the snow. It might be made useful on our pine stump lands, however, no nodules formed on these plants.

Hedysarum coronarium, Linn., Sulla. Late variety received from Malta, July, 1901. Planted June 20th. Germinated and grew slowly, 2 inches high July 27th, 6 inches high August 19th. Did not bloom. It is of no use here for it should grow 4 to 6 feet high. Our winter weather freezes it.

Onobrychis sativa, Lan., Sanfoin. Giving two cuttings of hay per season, received from France, September, 1901.

Planted June 12th, flowered August 10th to September 27th. Fruit September 27th, 3 inches high July 22d, 7 inches high August 19th, flower stems 12 inches high.

These plants are well established which is all that could be expected the first year. There are sandy hills in Michigan which are cropped with small profit or remain unused which should produce sanfoin hay year after year with little trouble after they are once planted with it.

Arachys hypogea, Linn., Peanut. Planted May 21st, first flowers July 13th, a few fruits matured. Vines 5 inches high July 22d. Michigan climate is too cold for peanuts.

Voandzea subterranea. African Goober. Planted May 31st, yellow flowers August 14th until frost, plant 5 to 6 inches high. Of no use in Michigan. No fruit matured.

Desmodium tortuosum, D. C., Giant beggar weed. Planted May 15th, flowered September 2d to September 27th, 8 inches high July 22d, 24 inches high August 19th, 36 inches high before killed by frost. Climate is too cold for it, a few fruits formed.

Lespedeza striata, Hook., Japan Clover. Planted May 15th, no flowers, 3 inches high July 22d, 5 inches August 19th, a fine densely tufted growth. It is sensitive to frost and was killed in the fall. It is not hardy enough for Michigan. Dodder attacked this plant but did little harm.

Lespedeza bicolor, Turez., from Japan. Planted May 15th, 10 inches high July 22d, 15 to 22 inches high August 19th, reached 36 inches before killed by frosts in the fall, no flowers. The climate is too cold and the season too short.

Cicer arietinum, Linn., Gran. Planted May 15th, flowers July 2d until frost, 24 inches high August 19th, fruit matured September 27th. It endures light frost. Though this plant grew vigorously no nodules were found at any time on its roots. It is grown in India for its seeds, but our climate is hardly hot enough.

Ervum lens hiemale, red winter lentil. Received from France, September 19th, planted June 12th, first flowers August 19th, 5 inches high July 22d, 7 inches August 19th. It continued long in bloom but set no fruit, it kept green all the fall and is green under the snow.

Ervum lens, Linn., Lentil. Planted May 15th, flowered July 1st, continued with flowers and fruit to August 19th, died in fall, 12 inches high July 22d, 12 to 16 inches August 19th. These plants produce little green matter and in this climate they do not fruit freely. They are of no practical value here.

Vicia orobus, D. C., from Crete. Planted June 12th, flowers July 17th, flowers and fruit August 19th, 6 inches high July 22d, 12 inches high August 19th, like Ervum lens but decidedly better as it remains very green from spring to winter. It also fruits freely, having 4 seeds in a pod.

Pisum sativum, Linn., Blackeye, Marrowfat Pea. Planted May 21st, flowers July 13th to August 19th, ripe fruit August 19th. Vines 39 inches long July 22d, the tangle of vines 24 inches high, August 19th, equal in growth to the field pea and seed more valuable.

Pisum sativum, Linn., Field Pea. Same as above but vines 36 inches long, field peas are much grown in this state and are especially valuable for the northern portion. Some farmers sow peas with oats for cows or with rape for hogs.

Lathyrus sativus, Linn., Seed from Moscow, Russia, June, 1898. Planted June 12th, first flowers July 21st, 10 inches high July 22d, stems 24 inches long August 19th. Continued in bloom until September 27th, a little fruit matured.

Lathyrus ochrus, D. C. Received from France, September, 1901. Planted June 12th, grew slowly at first, 3 inches high July 22d, stems 8 inches long August 19, flowers September 13th, no fruit was observed to mature. It forms a dense tangled growth which remains tender and green throughout the season. It is very hardy, remaining green under the snow. Perhaps no other species produce so large a weight of nodules. It is a promising species.

The Winter Flat Pea, *L. cicer*, Habl., was planted with rye on June 12th. It grew but showed no flowers up to the 19th of August, when it was 12 inches high. It remained green through the season and under the snow.

Lathyrus silvestris, flat pea. An early bulletin, in 1892, reported the yield and habit of growth of this importation from Germany. In 1895 and 1896 a great deal of attention was paid to the crop. The season of 1896 was damp and the crop was luxuriant. On June 29th one acre was measured off and on this and the two following days the crop was cut and weighed as fast as it could be hauled to the scales. The total product from the acre in the green state was 12 tons. The cured hay weighed 5,431 pounds. On September 16th following, the same acre was cut giving a yield of 3,636 pounds, or a little over one and three-fourths tons. The total yield of hay from the acre was four and a half tons. When it was attemptd to feed this Lathyrus hay to stock it was found that the latter had to be starved to eat it at all. Sheep were pastured on the green alfalfa but refused to eat it in sufficient quantity to sustain life. These facts, combined with the further one that the seed is extremely expensive and very slow to germinate and grow, makes the verdict of the station against the use of the flat pea for any purpose whatever on the ordinary Michigan farm.

At the conclusion of Mr. Barlow's work on the small plots it was decided to confine the future investigation very largely to soy beans, cowpeas and hairy vetch. The tests of soy beans and cowpeas were carried on, in 1903, on the series of station plots known as 33 to 71. The ground is level, thoroughly underdrained, clay loam. The seed was drilled in May 28th in rows 18 inches apart, the length of the rows, 8 rods. They were drilled in the following order, beginning at the west:

COWPEAS.

	Rows.	Lbs. Seed.
Chinese Red, No. 979	4	....
Down's Early, No. 1090	11	....
Unknown	11	....
Sherman's Northern Prolific	22	2.25
Iron	22	3.8
Taylor	22	4
Whippoorwill	22	3.75
Black Early	22	4.2
New Era	22	4.25
Browneye	22	3.5
Blackeye	22	4.75

SOY BEANS.

	Rows.	Lbs. Seed.
Early Black, Michigan grown	22	3.75
Medium Green, Michigan grown	22	5
Ogemaw, Michigan grown	22	4.5
Ito San, Michigan grown	22	3.5
9413, Department of Agriculture	22	4
9410, Department of Agriculture	22	3.75
9411, Department of Agriculture	22	3.06
8423, Department of Agriculture	11	1.25
9407, Department of Agriculture	11	1.75
9409, Department of Agriculture	22	6
Extra Early Black	22	3
Medium Green	22	3.2
Ito San	22	3.25
Yellow	22	4.25
Wood's	22	3.88
Medium Green, Selected, 3 ft. rows	12	
9409, 3 ft. rows	9	

The season was very wet and cool, greatly hindering the germination and growth. They were cultivated and hoed late in June and in early July. By the latter part of July the soy beans were in bloom and too large to cultivate. Other notes follow:

August 18. The Chinese red cowpeas, No. 979, were 12 niches high and carried buds nearly ready to blossom. All other varieties of cowpeas carried buds and measured in height as follows: Down's Early, 8 inches; Unknown, 8 inches; Northern Prolific, 8 inches; Iron, 14 inches; Taylor, 9 inches; Whippoorwill, 13 inches; Black Early, 13 inches; New Era, 10 inches; Browneye, 10 inches; Blackeye, 15 inches.

Of these varieties the Iron began to show considerable superiority by the middle of August, the Blackeye appeared to be next in quantity of foliage and in general thrift. Part of the seed, although showing no less a per cent of germination seemed to have been improperly stored or injured in some other way, making the stand of that variety defective. This statement is true of the Taylor, the Down's Early, the Unknown and the Northern Prolific.

On the 18th of August the height of the soys and the condition of bloom was as follows: Early Black, 30 inches and past bloom, the pods already carrying immature seeds; Medium Green, 36 inches in full bloom; Ogemaw, 32 inches, well podded, two to three beans in a pod; Ito San, 28 inches, in bloom and podded; 9413, 27 inches, in bloom, poor stand; 9410, 30 inches, just coming into bloom, poor stand; 9411, 10 inches, just going out of bloom, very small, stand very poor; 9407, 28 inches, in full bloom; 9409, 24 inches, coming into bloom; Extra Early Black, 24 inches, past bloom, well supplied with pods; Medium Green, 36 inches, in bloom; Ito San, 30 inches, in bloom with small pods; Yellow, 22 inches, not yet in bloom; Wood's 24 inches, not yet in bloom.

On the 14th of September the Early Black was loaded with pods which were ripening. The leaves were dropping off. The Medium Green pods were filling well, the stalks green and vigorous. On the same date the Ogemaw had ripened its seed fully, the beans were hard and nearly all of the leaves dropped away

from the stalks. The Ito San showed a greater number of pods but was not quite so ripe as the Ogemaw.

On the 24th of September most of the soy beans and all of the cowpeas except some specimen plants left to test the influence of frost, were harvested. None of the varieties of cowpeas gave any indication of ripening before frost. The early black soy, the Ogemaw and the Ito San were ripe, the leaves dead leaving the branches and abundant pods exposed. The medium green soy had made a dense growth and stood up nearly 3 feet high bearing large numbers of pods not yet mature. Of the varieties sent by the government for tests, 9413 was left uncut because bearing an abundant harvest far enough advanced to allow hope of ripening. 9410 was cut. It had quite a few pods but they were too small and too immature to allow hope for any ripe beans. 9411 had a poor stand, the plants were small but well podded and nearly ripe. 8423 had a very poor stand and at this late date was still in blossom. 9407 seemed to have a fairly good stand and produced an abundance of pods too small to mature this season. 9409 had a good stand but was too late a variety for this climate, just going out of blossom on the 24th of September. The early black, not Michigan grown, were not as well matured as those grown from seed produced in this State.

On the 15th of October the 9413 and the medium green were well advanced toward maturity.

September 24th was followed by ten days of continuous rain. The legumes cut on that date were at no time dry enough to haul to the barn until October 10th. They had to be turned frequently to prevent spoiling and the weights given below must be considered with this fact in mind:

Variety.	No. rows.	Yield.	
		Lbs. per plot.	Lbs. per acre.
Chinese Red, not harvested.			
Downs' Early, No. 1090	11	29	580
Unknown	11	43	860
Northern Prolific	22	48	480
Iron	22	130	1,300
Taylor	22	54	540
Whippoorwill	22	58	580
Black Early	22	96	960
New Era	22	150	1,500
Browneye	22	65	650
Blackeye	22	99	990
Soy Beans:			
9410	22	286	2,860
8423	11	53	1,060
9407	11	105	2,100
9409	22	395	3,950
Yellow	22	105	1,050
Wood's	22	279	2,790

The following varieties were harvested for seed October 24th. The table gives the yield of grain and straw:

Variety.	Rows.	Yield per acre.	
		Grain. Lbs.	Straw. Lbs.
Early Black	22	830	1,600
Ogemaw	22	570	1,120
Medium Green	22	700	2,500
Medium Green	22	970	2,650
Medium Green, selected		610	1,200
9413	22	510	1,850
9411	22	100	190
Ito San	22	860	2,450
Ito San	22	610	2,350
Early Black	22	440	800

On the evening of September 28th a frost occurred. All varieties of soy beans and cowpeas seemed to be equally affected by it. Again, on the 15th of October, after a heavy frost of the night before, the medium green soys being more succulent showed the greater effects of the cold weather.

The plots devoted to variety tests in 1904 were in A, east of a large grain barn, which partly protected them from severe west and southwest winds. The soil is a clay loam of varying character, changing to a very sandy loam at the east end of the plots and merging into a stiff clay toward the south side of the series. The plots were 18 rods long and for the most part 1 rod wide. The ground was plowed on May 16 and 17 and harrowed. It was again harrowed, rolled and thoroughly prepared on May 28 and 30. The plots ran east and west. The varieties tested were sown in the following order on June 1, the plots being numbered from the north:

Plot 1, Medium Green;
" 2, Ogemaw;
" 3, Early Black;
" 4, 9413, from U. S. Dept.

Four rows each of Ito San, Gosha, Rukigira, Rukugetsue follow next in order. On June 6 the soy beans were beginning to show a good stand. They were cultivated on June 13, 15, 22 and 28 and on July 6 and 8. They were hoed on June 15 and July 8. By July 9 the medium green soys were 11 inches high, were much darker in color than the Ogemaw and with a distinctly coarser and more hairy stem. The Ogemaws were a foot high, a little lighter colored and more delicate in appearance. The early blacks averaged 11 inches in height, the Ito San 11 inches and the Gosha 11 inches. The latter had peculiarly light colored, velvety leaves and gave a good indication at that date of being a distinctly early variety as did the Ito San. The Rukigiri and Rukugetsue gave no evidence of superiority over the rather better known and more standard varieties.

On July 21, the Ogemaw soys were in blossom and were 2 feet in height. The Ito San from northern grown seed, was also in blossom. The next day the extra early black began to show blossoms and on July 23 the early blacks came in bloom. The government 9413 did not show blossoms until July 30 and the medium green not until August 4.

By August 29 the medium green soys had full sized pods with the beans just nicely starting to develop, while the Ogemaws contained in the pods beans almost fully grown, and beginning to ripen. The early blacks were not as far along at this date as were the Ogemaws and the government 9413 were at about the same stage as the medium green. The Ito San seemed about half grown, the Gosha with pods full size and beans one-third size. The extra early black showed pods fully developed.

By September 2 the Ogemaw soys were ready to harvest with the leaves nearly all shed. The early black was not quite so far advanced as the Ogemaw and the Ito San had half of the leaves fallen with pods partly ripe. The Gosha was beginning to ripen, some leaves having fallen. This variety was not heavily podded as were the three others just mentioned.

The beans were harvested on October 10 by pulling and were left on the ground until the 17th and 18th when they were hauled to the barn. The gross weight of the entire plant was as follows, being the yield of a rod wide by 18 rods in length:

Medium green, 79 pounds; Ogemaw, 42.5 pounds; early black, 67 pounds; government 9413, 26 pounds; Ito San, 33 pounds.

On a separate area the medium green variety was grown for silage. It was harvested on September 29, yielding, green weight, 8,800 pounds per acre.

The variety tests of cowpeas in 1904 were conducted on series H of the station plots. The season was peculiarly unfitted for this semitropical crop and none of the varieties ripened much seed. Notes were made of the peculiarities of the different varieties although thy did not mature enough to warrant a record of the weights at harvest. The Missouri, Taylor, Clay, Iron, Wonderful, Whippoorwill and New Era attained a height of over 15 inches, the Missouri and Clay leading in this respect. The date of the first blossoming was August 18 for the Whippoorwill, Michigan Favorite, and Early Blackeye. The New Era, Black and Unknown began to blossom August 27; the Taylor, Sherman's Northern Prolific, Down's Early, the Iron, the Rice, the Red Ripper, the Clay and the Wonderful

began blossoming in mid-September or a little later, the Rice, the Missouri and the Wonderful being the last to blossom. The Michigan Favorite, Early Blackeye and Missouri have long tendrils, the Whippoorwill, the Wonderful, the New Era, Black, Clay, Unknown, Red Ripper, Taylor, Rice, the Down's Early and Iron, have no tendrils. The Clay and Taylor were very upright; the New Era, Iron, Missouri, Whippoorwill and Michigan Favorite were fairly upright although the last was a little inclined to sprawl upon the ground as were the Wonderful and the New Era. The Black made no attempt to stand up but was very spreading and recumbent; the Unknown, the Red Ripper, the Early Blackeye, Rice, the Northern Prolific and Down's Early were spreading, lodged and prostrate.

On the 11th of September one square rod was measured on the plots devoted to the following cowpeas, the yield of the square rod, weighed green, is reported below:

Wonderful,	56	pounds.
Whippoorwill,	40	"
New Era,	26	"
Red Ripper,	23	"
Black,	20	"
Clay,	37	"

In the spring of 1905 a square rod of the Whippoorwill variety was harvested, the leaves having fallen and disappeared, the stalks and part of the roots alone remaining. All of the stalks and roots on the square rod were gathered, weighed and analyzed. The weight of the stalks with roots attached was 13,375 pounds. The chemical analysis of these stalks showed the following results:

Water,	23.34	per	cent.
Ash,	8.84	"	"
Nitrogen,	1.23	"	"
Potash, trace.			
Phosphoric acid,	.95	"	"

A combination of this analysis and the weight on the square rod shows that the stems and attached roots of cowpeas left standing during the winter returns to the soil when plowed under, 26 pounds of nitrogen per acre.

HAIRY VETCH.

The station began the work with this crop in 1896, sowing a small area with oats, 25 pounds of vetch seed and 32 pounds of oats being used. The oats germinated so quickly and grew so rapidly that the vetches were not seen until the oats were harvested. On July 6 the oats and vetches were ready to cut, the oats being fully headed and ready to turn. Because the vetches had made such meager growth the harvesting of the crop was delayed until July 29, when the oats were fully ripe. The crop weighed, August 1, in rather damp condition, 2,132 pounds to the half acre. As soon as the oats were removed the vetches began to show themselves. They grew rapidly and completely covered the ground before the first of September. There was a severe frost on the 19th of that month which did not injure the vetches, though it stopped the growth of the second crop of sorghum on the adjacent plots. The attempt was made to feed the vetches to sheep but they refused to eat them until practically starved. They were hurdled on the vetches but would not eat them as pasture. Part of the plot was mowed and removed. On this part the vetches withstood the winter and were green in the spring of 1897, but where it was left unharvested the growth was so rank as to completely kill out, by smothering, all of the plants. The five square rods cut on November 12 furnished 430 pounds of green forage or at the rate of nearly seven tons per acre. Later in the season after the frost had killed all other green stuff, the cows seemed to eat the green vetches with avidity and the sheep did not altogether discard them. The vetch is a slender plant, the stems usually trailing upon the ground and reaching a length of six to ten feet. Under the name of Hairy Vetch a great number of different sorts are sold in the market. In the spring of 1899 a large importation of vetch seed, supposed to be correctly named, was made and the seed sown and tested.

It was found that the vetches going in American markets under the name of Hairy Vetch or Villous Vetch, included all kinds of vetches, some valuable and others entirely worthless, some with fine leaves, others with coarse, some bushy and erect, others recumbent, some covering the ground with a thick mat of vines, others giving but a sparse growth.

Vetches have been sown annually on the station plots since 1897. In the latter part of the bulletin, page 180, there is given a comparison of vetches and other legumes on the basis of their content of nitrogen, phosphoric acid and potash.

Complaint against the vetch having come to the station, an examination was made of a tract of country east of Howard City in Montcalm county. It was found that some vetch seed brought in some time prior to 1900, had been sown on farms of sandy loam soils. There was an enormous growth and the plants seemed so promising that the seed was distributed to many farmers in the neighborhood. Later it was discovered that the seed remained in the soil from year to year until conditions favorable to its growth obtained. On a single plant at the station over 1,000 seeds have been found. It is manifest, therefore, that where plants escaped the harvester and went to seed, the soil would be fairly certain to become a reservoir for vetch seed from which undesired specimens would rise to plague the farmer when the field was sown to wheat. Millers refused to buy wheat from that section of the country, because so many fields were infested with the vetch, the seed of which is nearly the same in size as kernels of wheat and of the same specific gravity. Moreover, the flour from wheat with which vetch seed is mixed, is poor in quality and makes a sticky dough and are altogether undesirable loaf. It is but fair, therefore, to warn farmers against the sowing of vetch on fairly rich soils. On the station farm where this plot of vetch grew in 1895 no vetch has been sown since, yet whenever the field is sown to wheat the blue flowers of the vetch show themselves and it is necessary to send men ahead of the binder to pull up the plants to prevent damage to the wheat.

Among the varieties or species of vetches to be recommended the following are perhaps the leading ones. They are ranged in order of maturity of their fruit on the 20th of August, the one with the most ripe fruit being placed first. No common names of the vetches are known. They belong to the genus Vicia. In the notes below the name of the genus will be represented by V., the name of the species following that letter

The vetches were planted May 13.

V. picta, Fisch. Flowers July 5, fruit August 19, 14 inches high, dead before September 27.

V. calcarata, Deaf. Flowers July 5, fruit August 19, dead before September 27.

V. cordata, Wulf. Flowers July 5, fruit August 19, 15 inches high, August 19.

V. segetalis, Thurill. Flowers July 5, fruit and few flowers August 19, 17 inches high August 19.

V. cornigera, Chaub. Light pink flowers July 5, fruit ripe and some seeds germinating September 27.

V. ambigua, Guss. Flowers July 5, ripe fruit August 19, 16 inches high.

V. sativa, Linn. Planted May 13, flowers July 7, fruit and flowers August 19 and until September 27, 24 inches high August 19.

V. sativa typica, improved gray vetch, received from Svalof, Sweden, planted June 12, too late to compare with other vetches. It was in flower September 27.

The above vetches have short stems yielding a small bulk of green matter, maturing seed early and in abundance and afterwards turn brown and die.

Below are given the vetches that reverse these conditions more and more as we advance in the list.

V. canadensis, Zucc. Light pink flowers July 17, vines 48 inches long August 19, fruit September 27, a desirable vetch yielding well in hay or seed.

V. angustifolia, Linn. Smaller red flowers July 21, stems 24 inches long August 19, remaining green into the winter.

V. peregrina, Linn. Southern vetch, flowers July 8, abundant fruit and flowers August 19, 24 inches high August 19, ripe fruit and a few flowers September 27, an excellent species.

If vetch seed is desired, select from among the first on the above list. If a large yield of hay is wanted select from the last part of the list.

The vetches named below have finer leaves and stem, minute white to pink

flowers, a few on each small peduncle, fruits very small, few seeded, the growth dense and mattted.

V. disperma, D. C. Flowers July 7 to September 27, matted growth 36 inches high August 19, fruit not abundant but a very large quantity of succulent green matter.

V. argigentinum, Guss. = *V. bivonea*, Rafin. Flowers July 16, fruit August 19, growth 32 inches; does not fruit freely but produces a large bulk of green material.

V. hirsuta, S. F. Gray. Minute flowers July 8, flowers and fruit August 19 to September 27, 21 inches high August 19. This species fruits freely but produces less growth than the preceding.

The following vetches have abundant, showy, red, purple or blue flowers, one sided on long peduncles; rampant leafy vines, forming a tangled mass. They are given in the order of their growth, the largest first. Few of them fruited freely.

V. biennis, Linn. Flowers June 21 to September 27, 48 inches high August 19.

V. ludoviciana, Nutt. Flowers July 16 to September 27, 36 inches high August 16. This species gives a thick, heavy, dense mass of vegetation over the entire plot.

V. gerardii, Vill. Flowers before July 7 and until September 27, showy blue flowers, 36 inches high August 19.

V. globosa, Retz. Red flowers June 21 to September 27, young fruit August 19, 35 inches high August 19.

V. narbonensis, Linn. Planted June 22, too late to compare with the other varieties and species. Its dark red flowers were conspicuous July 29 through the season to September 27. Its fruit was nearly ripe September 27.

The vetch known as horse bean, *V. faba*, Linn., has been grown annually but is unsuited to Michigan climate and conditions. It is regularly attacked by plant lice and practically killed.

While many of the vetches resemble each other closely others vary widely in appearance. Prof. B. O. Longyear, then botanist of the station, made a somewhat careful study of the botanical characteristics of the species of vetches growing on the station plots and suggested the following analytical key as an aid in discriminating between the several species. This key is confessedly tentative but will aid in placing a new vetch in proper relation to known forms.

ANALYTICAL KEY TO VETCHES.

I. Stems erect, stout; leaflets large, few tendrils poorly developed; whole plant glabrous, becoming blackened where dried.

V. sativa dura.

V. faba.

V. narbonensis.

II. Stems spreading or climbing; slender; leaflets mostly small and numerous; tendrils well developed; plant more or less hairy or pubescent.

A. Stipules, especially the lower, with several prongs, with a reddish glandular spot; leaflets numerous, truncate or notched, mucronate; flowers 1-3, sessile or short stalked in axils of leaves, purple.

a. Stems and pods velvety, more or less robust; flowers three-fourths to one inch long.

1. Pods one-half inch or more wide, robust, *V. sativa typica.*
2. Pods one-third inch wide, *V. peregrina.*
3. Pods one-fourth inch wide, *V. cornigera.*

(These three species form a descending scale as regards size and hairiness with *V. Sativa typica* standing at the head.)

b. Mostly slender, sparingly pubescent; flowers usually less than three-fourths inch long.

1. Leaflets mostly obtuse-truncate at apex, *V. grandiflora.*
   Leaflets oblong-linear, *V. angustifolia.*
   Stipules large, margin lacerated, *V. canadensis.*
2. Leaflets mostly retuse or notched at apex.
   *Stems and pods minutely pubescent, *V. segetalis*, *V. ambigua* (deeply notched).
   **Stems and pods nearly or quite glabrous, *V. picta*, *V. Calcarata*, *V. cordata.*

B. Stipules conspicuous, with numerous prongs, glandular spot pale; leaflets few, about 2 pairs, ovate to narrowly elliptic, apex often acute; flowers 1—several on a lengthened peduncle, pale blue, *Vicia bithynica.*

C. Stipules simple or once pronged at base (half sagittate), not glandular spotted; leaflets numerous obtuse or acute, mucronate; flowers one-sided, racemose or spicate few or numerous on a lengthened peduncle.

a. Flowers numerous, conspicuous, deep purple, stems pubescent.
*Pods glabrous, flowers blue purple, *V. gerardii.*
**Pods hirsute or hairy.
†Stems, and especially the pods, quite strongly hirsute, *V. onobrychoides.*
††Stems and pods sparingly hirsute, *V. globosa.*
Flowers reddish purple, *V. biennis.*

b. Flowers few, inconspicuous, usually pale purple, stems nearly glabrous.
*Pods glabrous, *V. ludoviciana.*
**Pods minutely hirsute or hairy.
†Flowers 1—2 about one-half inch long; pods 4—6 seeded, *V. cassubica.*
††Flowers 3—6, about one-fourth inch long; pods 1—2 seeded.
V. disperma.
V. argigentinum.

Vicia bithynica, L. Stems low, angled, branching at base, sparingly silky, slender, green; leaflets 1—2 pairs, rather large, obovate—narrowly lanceolate, tapering at each end, apex mostly acute, mucronate, sparingly silky; stipules large and conspicuous, margin spreading and laciniate, glandular spot pale; flowers 1—2 on a somewhat lengthened peduncle, 6 to 8 inches long, bluish. Pods 5 inches wide, one and one-fourth long, flattened, hairy, seeds 4—5.

VETCH AS HAY.

In the fall of 1899 several sowings were made with a view to growing them for hay the following season. One lot sown September 5 was used for early soiling, beginning June 11 and continuing two weeks, during which time one-tenth acre produced 1,676 pounds green feed. Another plot sown the same date, September 5, on light sand, was cut for hay June 11, producing one crop of 4,188 pounds cured hay per acre. Another tenth acre sown October 5, at the rate of three pecks per acre, three parts Gold Coin wheat and two parts winter vetch, was harvested June 25, producing 3,016 pounds cured hay per acre. Another seeding of one peck of wheat and one peck of vetch per acre, made October 7, 1901, on sandy loam soil, was harvested June 22, producing 4,300 pounds cured hay per acre. Another similar mixture similarly treated, produced 4,000 pounds cured hay per acre. This hay is not altogether palatable but cattle will eat it either green or dry and this new legume may be sown late in the fall, with the expectation of securing a crop of hay the next season.

SOY BEANS AND OTHER LEGUMES AS GREEN MANURES.

It is difficult to compare legumes as to the amount of plant food they will add to the soil if used as green manures. A season that is best for clover may not be best for soy beans. Cowpeas are tender and if an early frost be a severe one, they are killed outright by this before completing their growth. Soy beans are adapted to clay loams and clay as well as to sandy loams, while cowpeas have done better at the station on sand and sandy loams. The vetches will grow on clay loam but seem to find a more congenial soil when planted in sandy loams.

On the 23d of September, 1903, there were growing plots of soy beans, cowpeas, vetches, new seeding clover and second crop clover. On soil not widely differing in physical character, the soy beans, cowpeas and clover had abundant nodules on the roots, the vetches had a few nodules but were not well inoculated. The varieties selected for comparison were the Medium Green soy, the New Era cowpea, the *Vicia globosa* and the June clover, not the Mammoth nor the Alsike. Another soy, the Ogemaw, was also examined and its composition is recorded below. Its roots were free from nodules. Of the two samples of clover, one was from a field from which the hay had been cut and removed July 2 and the second crop allowed to grow and the other from a field seeded in wheat in the spring of 1903, the wheat harvested July 15. All samples were taken September 23, 1903. The soy beans, cowpeas and vetches were in rows 18 inches

apart. From one of these rows which in appearances, in height and in thrift, fairly represented the plot, there was removed 8 feet in length. This was done by digging a trench on each side of the row and 9 inches distant from it. The earth was then washed out or gently shaken out from the roots. As far as possible every rootlet was saved with all the nodules. This gave, of course, the total yield of foliage, stems, roots and nodules on 12 square feet. This material was taken to the laboratory and the forage separated from the roots at the point where the knife of the mower would have cut at haying. The forage and roots were then separately weighed and separately analyzed.

To secure a sample of clover to compare with the soy beans, cowpeas and vetches, an area 8 feet long by 18 inches wide was surrounded by a trench and the clover roots carefully removed and freed from adherent soil by shaking gently and by washing. The samples of clover were then divided into forage and roots just above the crown and were weighed and analyzed. The depth to which roots were taken in each case was 8 inches. The weights of the forage and roots on the 12 square feet of the several legumes were as follows:

Legume.	Forage Lbs.	Roots. Lbs.
Medium green soy	5.125	.454
Ogemaw soy	1.69	.25
New Era cowpeas	3.94	.319
Vicia globosa	1.25	.125
June clover, second crop	1.5	1.44
Clover, new seeding	4.625	.75

The results of the analyses of the above material are set forth in the following table, the per cent of ash, protein, nitrogen, phosphoric acid and potash being the parts per hundred of dry substance and not the per cents of total weight:

Legume.	Water.	Organic matter, per cent.	Ash, per cent.	Protein, per cent.	Nitrogen, per cent.	Phosphoric acid, per cent.	Potash, per cent.
Medium Green soy:							
Forage	76.56	91.14	8.86	18.53	2.97	.55	1.98
Roots	72.56	93.42	6.58	6.92	1.11	.35	.87
Nodules	51.15	....	....	26.19	4.19	....	2.05
Ogemaw soy:							
Forage	53.55	85.10	14.90	12.88	2.06	.80	1.20
Roots	74.90	94.34	5.66	5.07	.81	.36	.90
New Era cowpeas							
Forage	84.13	86.80	13.20	14.50	2.32	.51	2.92
Roots	60.36	91.36	8.64	7.44	1.19	.67	1.94
Nodules	70.23	....	....	24.39	3.90	.96	....
Vicia globosa:							
Forage	60.00	90.56	9.44	18.19	2.91	.68	2.38
Roots	50.00	94.21	5.79	15.13	2.42	.75	....
June clover, 2d crop							
Forage	50.00	90.52	9.48	10.87	1.74	.34	1.30
Roots	60.80	....	....	13.13	2.10	.55	1.28
Clover, new seeding							
Forage	78.33	91.34	8.66	15.42	2.47	.67	3.39
Roots	77.94	89.54	10.46	13.54	2.17	....	2.00

Since the table gives the proportions of the different constituents in per cent of dry matter, they are directly comparable. It is to be noted that the per cent of nitrogen in the dry matter of the forage of soy beans, cowpeas, vetches and new seeding clover, does not widely differ. The nitrogen in the nodules of the soy beans and cowpeas is practically four per cent of the dry matter, while the nitrogen in the roots is approximately one per cent where the nodules have been removed and over two per cent where the nodules were analyzed with the roots, as was the case with the clovers and the vetch. The per cent of potash in the forage of the clover, scarcely five months old from the seed, is significant. It is more than twice as high as in the dry matter of the forage of the second crop of clover.

The weights of forage and roots made when the samples were taken, gives the relation between the weight of forage and roots. It is possible, therefore, to construct the next table which gives the amount of nitrogen, phosphoric acid and potash in a ton of the dry matter of the forage and the roots which accompanies that quantity of forage. In other words, using a ton of the dry matter of the given legume as a basis, the amount of green forage is calculated; thereafter, the number of pounds of roots which naturally accompanies this quantity of forage is calculated and its content of nitrogen, phosphoric acid and potash added to the amount of these materials in the forage. The sums are set forth in the following table:

Legume.	Nitrogen, lbs.	Phosphoric acid, lbs.	Potash, lbs.
Medium green soy	64.97	11.68	43.04
Ogemaw soy	42.41	16.55	25.39
Cowpeas	52.98	13.23	67 09
Vetch	64.25	15.48	52.60
Second crop clover	64.34	15.06	45.22
Clover, new seeding	56.52	13.38	74.38

This table seems to show that in a ton of the dry matter of the legumes known to be inoculated, there is something over 64 pounds of nitrogen in the medium green soy, the vetch and the second crop clover. The new seeding clover and the cowpeas fall somewhat behind, while the Ogemaw soy, perhaps largely because at the date harvested, the variety had lost some of its leaves and was not inoculated, returns but 42.41 pounds of nitrogen in a ton of dry matter of the forage with the roots and nodules accompanying.

Were it possible to determine what an average crop of the several legumes under study really was, it would be interesting to compare the amount of nitrogen, phosphoric acid and potash supplied per acre by these plants used as green manure. An attempt to do this is made in the next table. The yields of the soy bean on acre areas on the college farm is known. The per cent of water in the hay was 20 per cent and the yield 5,860 pounds. The cowpeas yielded much less, the average being approximately 3,575 pounds of hay, 20 per cent water. The yields of the vetch were estimated from several square rods measured and weighed. The green crop of the *V. globosa* used in the experiment was approximately 8 tons per acre, with the per cent of water given in the former table.

In this particular year the new seeding of clover was very heavy. After the wheat was cut off July 15 the growth was fairly rank, so much so that the crop had to be cut and carried off the field to prevent smothering during the following winter. The approximate yields were, for the second crop clover, one ton per acre and for the new seeding 2,170 pounds of hay, 20 per cent moisture. It is not assumed that the yields given are typical or that they fairly represent the average yields of these crops over the State. Taking these yields as a basis and adding to the fertilizing ingredients in the forage the amounts that would be found in the weight of roots going with that amount of forage, the following table is constructed to show the amount of nitrogen, phosphoric acid and potash that would be supplied to the soil by the amounts of hay of the several legumes mentioned were the entire plants plowed under:

Legumes.	Hay, lbs.	Nitrogen, lbs.	Phosphoric acid, lbs.	Potash, lbs.
Medium green soy	5,860	152.29	27.38	100.89
Ogemaw soy	3,480	59.03	23.04	29.34
Cowpeas	3,575	61.90	15.45	77.20
Vetch	3,000	77 10	18.58	63.12
Second crop, clover	2,000	51.47	12.05	36.18
Clover, new seeding	2,170	49.06	11.61	63.55

If these crops are plowed under it must be remembered that the nitrogen is in organic form and will be available for subsequent crops very slowly. Bacteria must work upon the organic matter, digest and, by the decay, reduce the nitrogen to nitrate form. The other ingredients will also be inert and useless to crops until the organic matter shall have decomposed. This fact gives to the green manure plowed under certain advantages and certain disadvantages. The

plant food thus added to the soil is not readily washed out and the humus formed from it besides supplying slowly needed plant food adds to the water-holding capacity of the soil. What proportion of the nitrogen is lost in fermentation and the subsequent changes into humus and finally into nitrate is not definitely known and would depend upon many conditions. It is safe to asssume that a large part of the nitrogen is lost, escaping as free nitrogen into the air. If the soil is kept under good cultivation, if the soil particles are not too coarse and if the amount of water present be regulated by drainage and cultivation, the quantity of nitrogen so lost will be much reduced.

To give the matter of the relative values of soy beans and cowpeas in building up an exhausted soil, a plot 16 rods long 7 rods wide, which had borne sugar beets for seven consecutive years was divided into three equal parts, each 4 by 7 rods in area. On one of these plots soy beans were sown in 1903, on the next cowpeas and on the third buckwheat. In the fall it was found that the roots of the cowpeas were fairly heavily loaded with nodules while the soy beans had few. The green crops were plowed under and the whole area sown to rye in the fall of 1903.

In the spring of 1904 a strip 4 rods wide across all three areas was plowed, one rod planted to white beans, the next to field peas, the third to cowpeas and fourth to soy beans, leaving the rye nominally 49.5 feet wide but really 45.25 feet. By this method soy beans followed soy beans, cowpeas, and buckwheat and it was possible to make a study of the influence of the previous crop on that legume. The same thing was true of the cowpeas.

The rye was cut July 15. Where following the soy beans the yield was 407 pounds; after the cowpeas it was 387 pounds and after the buckwheat 367 pounds, the areas being equal, and 4 rods by 45.25 feet. The yield of grain was 134 pounds, following the soys, 115 pounds, following the cowpeas, and 119 pounds following the buckwheat. Through the season it was noted that the rye was slightly taller after the cowpeas; it was also slightly later in ripening on this strip.

The white beans occupied a strip a rod wide with equal areas on the plots which had borne in 1903, the soy beans, cowpeas and buckwheat, the area on each 1 rod by 4. The yields of straw and grain were as follows:

	Straw.	Grain.
After the soy beans	42 lbs.	25 lbs.
After the cowpeas	32 "	24 "
After the buckwheat	32.5 "	25 "

The field peas also occupied a strip 1 rod wide across the 3 plots. The yields were:

	Straw.	Grain.
After soy beans	82.5 lbs.	27 lbs.
After cowpeas	78.5 "	30 "
After buckwheat	72 5 "	25 "

Of the cowpeas, also 1 rod wide, the weights, green alone, were taken. The yields were 90 pounds after the soy beans; 99 pounds after the cowpeas and 91 pounds after the buckwheat.

The yield of the soy beans were 273 pounds after soy beans; 227 pounds after the cowpeas, and 231 pounds after the buckwheat.

The soy beans and cowpeas gave greater yields when grown the second year on the same area than when following each other. The rye had the highest yield after soy beans, as did the white beans and field peas if straw and grain are considered together. The field peas gave a greater yield of grain after the cowpeas. Before any definite conclusions can be drawn the experiment must be repeated.

ENSILOING SOY BEANS.

On the 15th of September, 1904, 13,590 pounds of soy beans, just harvested, were put into a silo.

Beginning in the last week of April, 1905, this silage was taken from the silo and fed to the cows. The silage had a peculiar and unpleasant odor which filled the whole dairy barn and was noticeable for many rods. The silage when weighed out amounted to 11,285 pounds and had the following composition:

Water	68.97%
Ash	5.69%
Ether extract	2.97%
Crude fiber	9.09%
Protein	3.28%
Carbohydrates	10.00%

In bulletin 103 of the Kansas Station, page 253, there is given the coefficients of digestion of soy beans when fed with kafir corn.

The Wisconsin Station reports unpleasant consequences in the flavor of the butter from the feeding of soy bean silage. When the silage was fed at this station a characteristic and unpleasant flavor was noted in the butter. The silage appeared to have kept in good condition. It was brown in color, not badly fermented nor soft but normal in texture and condition. The bad odor seems to be inherent in the silage itself and not due to abnormal fermentation.

There were 7,036 pounds of soy beans cut into the silo with an equal weight of corn. In this silage the same unpleasant odor was noted. Inasmuch as the soy beans do not grow tall and do not therefore stay bound in the bundle with the corn when cut with the harvester and inasmuch as repeated experiments at this station show that the vines of the Red Speckled and of the Southern Prolific beans cling to the corn and are harvested with it, it is suggested that one or the other of these legumes be used instead of soy beans for enriching in protein the corn in the silo.

THE DISCUSSION OF THE MILK PROBLEM FROM THE STANDPOINT OF PRODUCTION.*

CHARLES E. MARSHALL.

[Bulletin 228.]

The milk problem, as it pertains to the supplies of towns and cities, may be approached from two directions—the one as the consumer considers the question, and the other as the milk producer regards it. In our discussion of this problem, it is the purpose to approach it from the standpoint of the milk producer, because we believe this side seldom comes to light, and is less understood than that of the consumer. By doing this we hope to bring out some of the facts which will enable us to consider the whole milk problem more sanely and conservatively than is usually the custom without a knowledge of what the producer has to contend with. It is a pity that the city consumer, and usually the inspector, know so little concerning the cost of producing milk and those steps in manipulation necessary to the securing of a pure milk. Since this knowledge must furnish the appreciative spirit and rational interpretation, may we be permitted to view the situation in a concrete form and supply facts which are not usually considered by sanitarians?

If, as is sometimes recommended, a model stable is erected, such as is frequently taken as a type in sanitary contentions over the milk problem, we shall find that there must be something like $15,000 or $20,000 invested in buildings for a proper conduct of the dairy. It is not required that so much money be invested in stables to secure pure milk, but is the actual investment in some instances, and may be properly considered here Pure milk may be obtained with moderate priced buildings, and we shall show later how greatly the expenses may be reduced by moderate capitalization.†

* This paper was read in part before the "Conference of Health Officers of the State," June 2, 1905.

† It should be borne in mind that the cost of milk is subject to wide variation, because of the variable conditions and factors which control it. Our purpose is to put in definite form, so far as feasible, estimates which will represent fairly the usual cost of milk production, as gained from various sources, and subjected to the criticism of competent practical men.

Those who rent real estate, hoping to get back what they invest at a fair rate of interest, do not feel that they can take less than 10 per cent of the investment in rent. When repairs, taxes, insurance and the ordinary depreciation in the value of property are taken into account, it must appeal to every investor that this is only a fair rate of interest on such investment. If this is true of a dwelling house, it is also fair to suppose that it would be true of a barn or stable investment. Ten per cent of $20,000 is $2,000. This stable should have a capacity for 100 milch cows. If these are fair cows, they will average at least $75* each, or $7,500 invested in cows alone. Animals are not so long-lived as a building, and are likely to cease giving returns at almost any time because of sickness and various other troubles which are peculiar to animals. It is doubtful whether 20 per cent would be too high a rate of interest to place upon these animals. This amounts to $1,500 per year. The total investment, therefore, ought to bring $3,500 each year. Now what may be expected as an income, under the conditions named? Each cow of the type mentioned should produce at least 5,000 pounds of milk per year, or 2,500 quarts. If this is sold at the stable for three cents per quart, we have an income of $7,500. Out of this must be taken the cost of labor and the cost of food. The cost of food will average about $53 per head, or for 100 head of cattle, $5,300. The cost of labor will average about $25 per head, or $2,500. It is true that there will be other small items of income, but, on the other hand, there will be other incidental expenses, which we shall allow to offset each other. Our total expenses, therefore, for the year, would be $11,300, and our income $7,500 per year, leaving a deficit of $3,800 per year. In order to make this good, it is necessary to raise the price of milk at the stable from three cents per quart, upon which these calculations are made, to four and one-half cents. In order to retail milk, delivering to customers in the city, it is necessary to add 100 per cent to the cost. In other words, milk should cost the consumer in the city, at least calculation, nine cents per quart. This assumes that all conditions are ideal, that there are no profits above expenses, and that there is no high priced manager conducting affairs, and further that everything is done in a very moderate way unless the *high priced barn be considered.* If everything were to be carried on in an ideal manner, it will be found that a price of twelve cents per quart is not too high for the quality of milk which is sometimes furnished. It is possible and perhaps desirable to reduce the investment in the stable to $5,000; this would lessen the expense by $1,500, which in turn could be applied upon income for a competent manager and profits from the business, keeping, therefore, the cost of milk about the same as already estimated. Under the dairy conditions which exist in Michigan, many cows do not furnish 3,000 pounds of milk per year, therefore, scarcely pay for their keeping. It is safe to estimate in the face of Beach's figures, $53 per head or even at $40 per head for feed, that there are more cows in Michigan not paying their cost of keeping than there are which do pay profit. In the advocacy of pure milk supplies, while we may have very high ideals, it is essential that we investigate conditions as they exist. Considering the milk producer's side, it is easily seen that a pure milk supply cannot be furnished every town or city at will, but must be a matter of growth and development. The dairies surrounding a town or city should be managed for profit as well as purity and also for future possibilities, since years are required to get together a profitable herd of dairy cows.

†Estimate of cost of production of pure milk, based upon:

Time = 1 year.
Feed = $53—$40 per head.
Cow = 2,500 quarts milk.
Labor = $25 per head.
As constant factors.

* Prof. Beach's figures are used as a basis. He places the value of the cow at about $60.00. Everything taken into consideration, $75.00 will not be found extremely high.

† Bulletin No. 166 (1899) Michigan Experiment Station.—C. D. Smith.
Bulletin No. 29, (1904) Storris Agric. Experiment Station.—C. L. Beach.

Director C. D. Smith in bulletin No. 166, 1899, of Mich. Station, makes the cost of feed per cow $35.96. At this time, on account of higher prices for the various food-stuffs, $40.00 per cow may be regarded as the lowest extreme. There should also be taken into account the relative costs of feeds for Connecticut and Michigan, the latter being more favorably located for securing lower prices.

	Highest.	Lowest.
Investment:		
Buildings (stable, dairy, etc.)	$20,000	$5,000
Cows, 100 head	7,500	5,000
	$27,500	$10,000
Interest on Investment:		
Buildings at 10 per cent	$2,000	$500
Cows at 20 per cent	1,500	1,000
	$3,500	$1,500
Expenses:		
Interest	$3,500	$1,500
Manager	1,500	1,500
Feed	5,300	4,000
Labor at $25	2,500	2,500
	$12,800	$9,500

Income:

250,000 qts. milk (2,500 per cow) at 3 cents per qt. at stable	$7,500
250,000 qts. milk, at 5 cents per qt. at stable	12,500

Permit other receipts and expenses to offset each other.

Loss under highest estimate =	$300
Loss under lowest estimate =	2,000
Gain of lowest estimate with high priced milk =	3,000

Another phase of milk production in my judgment does not usually appeal to the sanitary commenter or milk consumer. If one were to make a close investigation with the idea of determining how many farmers are capable of producing milk *profitably* and *in a pure form*, I am certain it would be found that less than one per cent could fulfill the requirements. A man capable of producing milk that will answer the requirements of the sanitarian is an unusual agricultural man and one fit for success in almost any profession. He must be a thoroughly capable man, and, being a capable man, of course demands a fitting remuneration. His profession and himself are too little appreciated by society and scientific men. It is necessary that he know how to breed animals successfully and by so doing develop their capacity for milk production, at the same time keeping his animals sound. He must know how to feed animals economically and in such a manner as not to create any physiological disturbance, thus giving rise to an abnormal flavor or aroma in the milk, and still maintain the yield and richness of the milk. It is necessary that he not only have this as theoretical and scientific knowledge, but he must also be able to apply his notions in a practical manner, reaching every individual animal and every detailed operation under his care, for every animal has its idiosyncrasies, and these idiosyncrasies, to a large extent, determine profit or loss, and every operation must be adjusted to circumstances; in other words, he must be a man of great resources. He should recognize and diagnose immediately any disturbance in an animal or any factor which may cause bad milk or decrease its flow. The relationship between milk production and physiological processes he knows in a practical way, better than a scientist knows from analysis, and can usually give more satisfactory answers. The producer of milk must be acquainted with milk and its handling, he must appreciate that the feeding of ragweed, chickweed, silage, turnips, and many other substances well known to him will give rise to an undesirable quality of milk, must also know that certain diseases alter the milk, that others are dangerous, and must understand that many physiological and emotional disturbances may change the character or nature of the milk. These things he has learned from science and experience, and one by one he has mastered them to the extent that he is able to meet at a moment's notice any of the usual emergencies which arise. This side of the production of milk is seldom brought forward, and people too little realize what it means to produce pure milk or what it costs. If the consumer in the city finds that his milkman is raising the price of milk one cent per quart, he immediately concludes that there is so much clear gain going to the producer, accordingly, when once the price and standards are established, it is very difficult to change. If a hardware

merchant raises the price of some article, as nails, that merchant at once conveys to his customer that it is due to an advance in steel. A few years ago bran could be secured for a few pennies per hundred, hay was cheap, and all the foods which are necessary for the feeding of cows had a low market value as compared with present prices. The cost of the food of one cow, which a few years ago would not amount to more than $20 per year, at the present time, as has been stated, has gone to $53. The price of milk, however, has undergone little change. It would seem, therefore, to arrive at a satisfactory conclusion in the matter of pure milk production, all controlling factors and circumstances should be carefully weighed by inspectors and consumers, what it costs to produce milk, the ability required in the milk producer, as well as stringent regulations in handling.

Competition is no mean influencing agent. It is a well known fact that in our smaller places, reliable farmers have attempted to produce a good quality of milk for their customers and to sell it at a fair price. Their charges estimated from cost of production, have been very reasonable, say six cents per quart. After starting, some irresponsible man would undertake to sell milk at three, four, or five cents per quart; consequently the good milk was soon crowded out and there was left upon the market only this poor quality of milk. This irresponsible man could then raise the price of his milk.

Another feature which is very important may be considered. It is safe to estimate that at least ninety per cent or even more of the people of any town or city are unwilling to pay extra prices to secure a product which is guaranteed to be clean and free from disease germs. They simply demand cheap milk and they usually get it.

It may be excusable to introduce at this point some directive words concerning the handling of milk. Milk, as it comes from the udder of a cow, is not absolutely free from germs, the number ranging anywhere from 0 to 3,000 per cubic centimeter. These bacteria present when milk is drawn from the animal are not seriously detrimental to the product if properly handled unless some disease producing germs are in it; but if improperly handled, trouble may arise even if the milk is as pure as a milk producer can secure it. Proper handling of milk applies equally as forcefully to pure milk supplies as to contaminated milk supplies. For instance, it is nearly as essential to keep pure milk cold as it is to keep foul milk cold, but this may be said: Where pure milk is produced there it little trouble with methods of handling, for whoever will produce pure milk will handle it properly. Most of the contaminations to which milk is prone will be found during the milking process and in the manipulation before cooling or bottling. Contaminations are in the form of the dirt from the animal, from the stall, from the bedding, feed and floor, from the utensils, and from the milker. In order to successfully eliminate these various forms of filth, it is necessary that the manager understand bacteriological principles as well as the surgeon. The problem the producer has to contend with is fully as complex as that which the surgeon meets; the surgeon has his complications, so also the milk producer; the surgeon has his fee of one or two hundred dollars for a single operation, but the milk producer has his meager gains and condemnation if everything does not result satisfactorily. I bring this to the front not to complain of the intelligently directed skill of the surgeon and his very modest fees, but to illustrate a serious state of affairs in milk production. A surgeon is protected by law, but every ignorant man thinks he can produce milk, and sell it for less than it really costs. The dairyman must sterilize his utensils, must eliminate the dust of the stable, must guard himself to insure cleanliness; the cows must be thoroughly groomed and cleaned; in fact, if you compare one operation with the other, there will be found many points of similarity existing between the milk manipulator and surgeon. You say a surgeon should be a pathologist, a physican, etc; this granted, the dairyman must be an agriculturist, breeder, etc.,—they balance up very evenly. If this is true, can an untrained and inexperienced farmer produce a good milk? Are we not asking too much? It is the same old story with sanitarians as with all mankind—we preach what we do not know, we expect ideal conditions where only fair are possible, we advocate the things of the millennium when we are just emerging from barbarity.

It would be advantageous to have a stable which can be kept clean, stalls which would contribute no dirt, cows which were so thoroughly cleaned and clipped

that no dust or dirt would fall from them, a milker dressed in a duck suit and sterile, a milk pail that is free from any contaminating material, and proper apparatus for aërating, cooling, and bottling milk—I repeat that it would be advantageous; it is practical, but only to the man who can carry these things to execution. Only one man out of every hundred milk producers is capable of doing it, in my judgment. It would also be desirable if there could be a separate milking room with all the conveniences, the water supply, cooler, aërator and other utensils, and the foul odors of the stable completely eliminated, but all of these conveniences must accord with the cost of production. If the consumer is willing to pay ten or twelve cents per quart for his milk, then the milkman or the milk producer should be compelled to produce that quality of milk; but if, on the other hand, the consumer is willing to pay only five or six cents per quart, then the consumer must expect to have that quality of milk furnished to him. At five cents per yard you cannot buy silk or broadcloth, but you can buy certain kinds of cotton. If we are to fight for a pure milk supply, let it be a fight for something that is definite and to the point; something that we know can be produced; it must be something that we know can be produced at a profit to the producer. Let the matter be put on a business basis. If we demand an eight cent milk and know exactly what eight cent milk means and can specify by contract, the producer who is willing to so contract should carry out the terms of his contract or go to the wall. It follows from what has been said that in order to place our milk supplies upon a more favorable basis, it will be necesary to establish specifications and then endeavor to find such men who are willing to furnish milk according to specification. Let the five cent man furnish five cent milk, the eight cent man, eight cent milk, and the ten cent man, ten cent milk, and let it be the business of the inspector to not only see that these specifications are fulfilled, but let him see also that the consumer knows the difference between five cent milk and ten cent milk. This will be an attempt in the right direction, will be an open deal between producer and consumer, and will be fair to all parties concerned. Under such specifications it will be necessary that an inspector know his business. He will be neither all producer nor all consumer; neither medical man nor veterinarian; neither bacteriologist nor chemist, but he will be a man trained for a special purpose, trained in all scientific and practical subjects, so far as they pertain to milk production and consumption, and if trained properly, will be able to adjust all differences satisfactorily. To my mind, there is no necessity for arbitrary compulsion; no necessity for city authorities antagonizing milk men; nor, on the other hand, should it be necessary for milk producers to defend themselves and resort to dishonest methods unbecoming men. Let the fight for pure milk be an open, business deal between man and man. The necessity for pure milk exists. Few realize it more than the writer. The author is heart and hand in the movement, but unless this can be accomplished in a manner that is just to all men, then it will be as well to let it drop until it can be dealt with frankly. In personal encounters with milk producers, the writer has found that there are hundreds of ways by which they can outdo the milk inspector or overcome any compulsory enactment; in personal encounters with milk inspectors, ninety-five per cent or more of them neither know what milk production is, what constitutes the proper handling of milk, or the significance of consumption of bad milk. They have learned mechanically to test for fat by the Babcock method, have learned how to stick the lactometer into milk, perhaps can make a plate for counting germs, but that is all. Scarcely one of them can give the significance of a single test. What good does it do? It keeps the milk man angry and they constantly devise ways of circumventing the regulations. Co-operation which is mutual will yield the best fruits. Most men know when they have fair treatment. As it stands at present, the farmer thinks he knows his business better than the inspector and the inspector thinks he knows his business better than the farmer, when both are densely ignorant of their own and the business of each other. The chasm between is immense and needs bridging.

It may be pertinent to enumerate many of the subjects to be treated in the production of pure milk. Each item needs further explanation and discussion when carried into practice, otherwise interpretation would be difficult under varying conditions and circumstances. In carrying such a scheme into execution, it will also be necessary to select such items as may seem fair in the production of five cent milk, such as may seem fair in the production of six cent milk, and

so on with the production of each grade of milk until *all* are embodied in the best grade.

The milk producer should therefore agree, depending upon what grade of milk he wishes to produce:

1. To provide and compensate a competent man to conduct the tuberculin test.
2. To apply the tuberculin test whenever ordered by the inspector or whenever in his judgment it is thought desirable.
3. To place in the hands of the inspector a copy of the records of temperatures and reactions.
4. To isolate any animal responding to the tuberculin test.
5. To pay any expense incurred by the test, breakage of thermometer, et cetera, which may not be herein mentioned, other than the duties and offices contributed by the milk inspector himself.
6. To sell no milk from any cow which reacts to the tuberculin test.
7. To remove any cow from the sound herd which, in the judgment of the milk inspector, may be regarded as unsound in any respect.
8. To sell no milk from any cow which may be pronounced unsound.
9. To furnish no milk to any one within the boundaries of town or city if any contagious disease is established in the family of the milk producer, unless circumstances will warrant permission from the milk inspector.
10. To keep the stable clean in the opinion of the milk inspector.
11. To properly ventilate the stable and dairy room.
12. To properly drain the stable.
13. To bed with clean straw or anything equally acceptable to milk inspector.
14. To provide pure water for the cows.
15. To provide sufficient and suitable food for the cows and nothing which will injure the milk.
16. To groom the cows thoroughly.
17. To have sufficient room about the cows or sufficiently large stalls.
18. To give the cows sufficient exercise.
19. To clip the hair from udder as often as it may be necessary.
20. Sponge the udder off with tepid water and take up any surplus moisture before milking.
21. To insist that each milker wash his hands carefully before milking.
22. To wear clean and sterile clothes while milking.
23. To provide a milking room, if required.
24. To have all pails, cans and utensils perfectly cleaned with warm water, sal soda, lime water, and boiling water as directed by milk inspector.
25. If milking is done in stable, to remove immediately after milking each cow's milk to aërator and cooler.
26. To cool the milk down at once to 40 degrees Fahrenheit, or below by passing over cooler.
27. To maintain milk in cans at temperature of 40 degrees Fahrenheit, or below until delivered.
28. To use milk pails, milk cans and other milk utensils for milk only.
29. To provide 40 pounds of ice for every 100 pounds of milk produced.
30. To use no milk from a calving cow till twelve days after calving.
31. To use no preservatives, dilutents, or adulterants in the milk.
32. To maintain a specific gravity of at least 1.029 in milk.
33. To maintain at least 3.5 per cent butter fat in milk.
34. To maintain at least 12½ per cent total solid.
35. To maintain a bacteriological cleanliness satisfactory to inspector.
36. To furnish a list of patrons to the milk inspector and correct it weekly.
37. To contract with the milk inspector, who will represent the municipality, to produce a certain quality of milk specified in agreement.
38. To carry out any suggestions of the milk inspector that are considered necesary for the health of those consuming the milk and for the good of the milk.
39. To keep the milk inspector informed or any irregularities in the herd or dairy.
40. To unite with the milk inspector in seeking improvement so far as it is feasible.
41. To sell no milk other than that coming from the milk producer's cows without the consent and approval of the milk inspector.

The contracts should embody in them detailed and full specifications as to:

I. Stables.
- a Location.
- b Drainage.
- c Structure.
- d Ventilation.
- e Lighting.
- f Space.
- g Stalls.
- h Milking room.
- i Cleanliness.
- j Water supply.

II. Cows.
- a Soundness.
- b Condition.
- c Number and kind.
- d Grooming.
- e Clipping of udder.
- f Exercise.

III. Feed.
- a Kind.
- b Quantity per cow.
- c When fed to cows.

IV. Milker.
- a Health.
- b Neatness.
- c Clothes.
- d Hands.
- e Method of Milking.

V. Dairy.
- a Location.
- b Drainage.
- c Structure.
- d Lighting.
- e Ventilation.
- f Plumbing.
- g Cleanliness.
- h Space.
- i Equipment.
- j Water supply.
- k Ice supply per 100 lbs. milk produced.

VI. Utensils.

a Milk pail.		Kind.
b Cooler.	as to	Cleanliness.
c Other Utensils.		Managment.

VII. Management of Milk.
- a How milked.
- b Where milked.
- c When cooled.
- d How cooled.
- e How sold.
- f How delivered.
- g Temperature of milk at time of delivery.

Laboratory of Bacteriology and Hygiene, June 10, 1905.

A POPULAR REVIEW OF SPECIAL BULLETIN NO. 33 ON "THE ASSOCIATIVE ACTION OF BACTERIA IN THE SOURING OF MILK."

CHARLES E. MARSHALL.

[Bulletin No. 229.]

For the last two years the attention of the writer has been directed to the determination of the favorable influence which certain microorganisms, usually producing no acid, frequently digesting milk, and many times curding milk, exert upon the growth of lactic bacteria (those germs commonly souring milk) accordingly hastening this process. It is understood that these lactic bacteria in milk cause the changing of the sugar of milk into an acid, called lactic acid, and this in turn acts upon the casein of the milk or the cheese content of the milk, producing a lopper. The bacteria which exert a favoring influence through a partial digestion of the milk, find their way into the milk through the filth of the stable, as, hairs of the cow, dirt from the cow, dirt from the floor of the stable, dirt from the feed, dirt from the milking utensils, in fact, they reach the milk through any avenue which is likely to be contaminated in any degree with dirt of one nature or another. It follows, therefore, that there is present in the milk a mass of bacteria consisting of many kinds,—those which are capable of souring milk directly; those which are capable of growing in milk and digesting it, leaving only a watery fluid behind; those which are capable of curding the casein or cheese product under sweet or sour conditions; and many other kinds which are able to produce various alterations. Our associative studies in this instance are confined to the lactic bacteria and a few of those which usually digest milk without an appreciable formation of any acid.

It has been suspected for some time that the lactic type of bacteria does not always account for at least occasional peculiarities noticed in connection with the souring of milk. With the knowledge that this souring is produced by a definite lactic micro-organism in most instances, its isolation and its cultivation in sterile milk ought to yield the same results as one would succeed in getting in the souring of milk under dairy environments. This, however, is not always true. Through the discovery of these influencing micro-organisms upon the lactic germs, it is possible in part to explain many of the variations which occur in the production of sour milk by lactic bacteria.

While the associative studies in connection with the souring of milk are more or less in an inceptive stage, they are along the same line as several other fermentations which have already been familiar for many years. The nature of vinegar fermentation, with which we are all somewhat acquainted, is something that will appeal to every layman not fully in touch with the technique of microbiology. It is a matter of common knowledge that in the production of vinegar, alcohol is first manufactured by a yeast plant from the sugar of the fruit. Following the production of alcohol, bacteria develop which convert the alcohol produced by the yeast into an acid, called acetic acid, which yields the vinegar of commerce. This association is required to yield the proper fermentative results. The yeasts are practically necessary for the cultivation of the bacteria and the bacteria are essential in the production of acetic acid or vinegar. In several fermentations, associative life exists, as is met in kephir and koumiss, ginger beer, and others. Again, in disease mixed infection frequently occurs. This mixed infection many times hastens the development of the disease and perhaps there are cases where it acts as a hindrance. Diphtheria in its pure form is caused by a rod-shaped micro-organism and pursues a definite course, but when mixed with a certain spherical micro-organism, an aggravated form of the disease may follow. In the soil are instances of associative growth: for instance, it has been demonstrated that there is a distinct germ which is capable of liberating

free nitrogen from combined nitrogen, but that this liberation does not take place through the agency of this germ very freely unless there is associated with it another micro-organism which is known as the colon germ.

These examples will be sufficient to meagerly illustrate the possibilities of association in a world of micro-organisms. Farmers have doubtless recognized that certain plants grow only in the presence of other plants,—again illustrating in the higher world the effect of associative development. This may doubtless be extended into the animal kingdom, and perhaps could be carried into regions which we know nothing about at the present time.

By the studies conducted in this laboratory, it has been possible to demonstrate that when the lactic bacteria are associated with certain other bacteria the lactic germs are capable of producing a greater amount of acid through this association than when grown alone without the influence of any other germs; that the milk in which the two germs are grown will lopper sometimes as many as 72 hours earlier than the milk in which the lactic germs are grown alone; that the number of lactic germs also increases much more rapidly when under the influence of association than when alone. Allow A to stand for the lactic bacteria, B to stand for the associated type, then the number of lactic germs developing in single and combined culture may be represented as follows:

$$A : A + B : : 27 : 1614$$

It is also interesting to note that if we should allow the germs designated by B to grow in milk for 48 hours, then kill them by sterilization, the milk in which they have grown will give the same results as when the living germs B are grown with the lactic germs. Products are formed by the growth of germs B in the milk which do not yield to sterilization; in other words, they are stable. These products have the same influence upon the lactic germs in influencing their growth, in hastening the formation of acid, and in reducing the number of hours necessary for the loppering of the milk as the living germs B. We may conclude, therefore, that the products are probably the important influencing agents.

While it has been positively shown that certain micro-organisms may influence the lactic bacteria in the souring of milk by hastening the process, and also that these micro-organisms apparently exert their influence in the milk through the formation of distinct products which in turn are capable of accomplishing in the growth of lactic germs what the living germs have been demonstrated to accomplish, there are also other factors entering into the study of this associative action which must be carefully considered, otherwise erroneous conclusions are likely to creep in. Among these factors the most important to the mind of the writer is that of the possible variations in our cultures resulting apparently from the differences existing in milks. At first it was suspected that by the use of dairy milks these differences in milks could be explained by the formation of bacterial products through the rapid development of germs usually pervading dairy milks. Studies conducted to determine whether this would lead to the probable explanation resulted in finding some variation, for by taking samples of milk from the dairy at different times it was discovered that when tested the usual variation in acidity existed, but if subjected to heat the milk did not always respond the same even when the acidities, measured by phenol-phthalein, were identical. For instance, 20° sometimes loppered and sometimes did not upon heating; 21° sometimes loppered and sometimes did not upon heating; 22° sometimes loppered and sometimes did not upon heating. If acidity measures the time of loppering of milk, then we must conclude that the indicator is not at all reliable; if the acidity is not the cause, we must seek another explanation for the variation secured in this test. Going to the cows themselves and securing milk that was perfectly fresh, it was found that the acidities, measured by phenol-phthalein, were marked by great variations. To illustrate:

Red Polled	Pansy Belle	gave	9° acidity.
	Grade 31	gave	18° acidity.
Holstein	College Houtje	gave	5° acidity.
Swiss	College Becky	gave	13° acidity.
Holstein	College Belle	gave	14° acidity.
	Grade 11	gave	17° acidity.
	Grade 17	gave	18° acidity.

Here is found considerable variation in acidity and, when these same milks were employed for the cultivation of micro-organisms, it was also discovered, that micro-organisms responded differently to these different lots of milk. Whether this response may be attributed to the acidity is not positively demonstrated, for we know from past knowledge that the constituents of milk vary widely; that is, the fat is subject to great variation as well as the casein of milk. There may be some relation existing between the acidity and the normal constituents of milk and instead of finding that the micro-organisms respond to the degree of acidity, it may rather be found that they respond to the amounts of different constituents present. Besides finding that the germs respond differently to milks from different cows, it was also found that milks gave different results upon the addition of rennet; that is, the milks from different cows curded upon the addition of identical amounts of rennet in different periods of time. We may conclude tentatively, therefore, from our studies of different milks, that the results secured from the cultivation of germs in these different milks are subject to as great variations as the results of chemical analysis. Bearing this in mind, in order to secure satisfactory results in a study of associations of germs in milk, it is necessary to restrict oneself to milk from the same source and treated in an identical manner, otherwise unreliable data will be obtained. It has been found necessary to introduce this brief survey of milk variation in order to satisfactorily interpret our studies in association.

When germ B, or the germ which we have employed in connection with the lactic bacteria, has grown in milk for different periods of time, certain definite changes are produced. Inasmuch as these changes give rise to the products which we have shown may influence the growth of lactic bacteria as much as living germs themselves, it is interesting to know what this breaking down or digesting of the milk may be. Studied from the chemical standpoint, we shall find that the casein or cheese substance of the milk is almost completely dissolved and in its place are simpler nitrogenous products, such as peptones, amido and ammonia compounds, as well as other products of more or less complete digestion. It is impossible, from our present data, to definitely point out which of these products favorably hastens the growth of lactic bacteria. It may not be a single one, but several combined. At any rate, the digestion is doubtless the means of furnishing such products as will hasten the growth of lactic bacteria. It must be understood, too, that the products resulting from these particular germs are not identical with the products of all germs of this class, for we find germs which apparently digest milk in much the same manner, but have apparently no influence whatever upon the growth of the lactic bacteria. This would indicate perhaps that instead of some of these main products of digestion, which are indicated in our discussion as being the cause of the facilitated growth, that a secondary product, which is not apparent at all in our analysis, is the real stimulant of the lactic bacteria.

We can further say that no acid is produced by germ B, which we have studied so thoroughly. Although when grown in milk, germ B will in time curd the milk upon heating, we have demonstrated that it is not due to the presence of any acid, but to other products which are found in the digested milk. Besides germ B producing a favorable action upon the lactic bacteria, we have met with several others which are also capable of doing the same thing, but varying in degree only. Out of ten which we have partly studied, six are capable of favorably influencing the lactic germs.

It is also interesting to note how much association may influence the butter products. Mr. Wright has conducted some experiments in which he has demonstrated that in order to cover up the disagreeable odor and taste produced by germ B it is necessary to employ 45 per cent of good starter in the ripening of cream. It is desirable, perhaps, to introduce at this point a summary of Mr. Wright's work.

Cream Lot.	Division of Lot.	Amount of B Added.	Amount of A Added.	Condition of Butter.
I.	1	5%	2½%	Very strong of B.
	2	5%	5 %	Very strong of B.
II.	1	...	5 %	Tainted.
	2	5%	5 %	Very strong of B.
III.	1	...	8 %	Very good.
	2	5%	8 %	Qute strong of B.
IV.	1	...	15 %	Very good.
	2	5%	15 %	B easily detected.
V.	1	...	20 %	Excellent.
	2	5%	20 %	B easily detected.
VI.	1	...	25 %	Strong; B easily detected.
	2	5%	25 %	B easily detected.
VII.	1	...	30 %	Excellent.
	2	5%	30 %	B easily detected.
VIII.	1	...	35 %	Excellent.
	2	5%	35 %	B easily detected.
IX.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
X.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
XI.	1	...	40 %	Excellent.
	2	5%	40 %	B easily detected.
XII.	1	...	45 %	Excellent.
	2	5%	45 %	B practically disappeared.

This association of germs studied may cast some light upon the peculiarities or irrregularities of milk souring known to nearly everybody; it may be the means of giving better basis for advocating purer milk for infant feeding and other purposes, since the products, at times perhaps toxic, are so stable; it has already given a more rational view of starters and their control, as well as of the extent of their possibilities; and it has made lactic fermentation one subject somewhat to other microbial factors which have not heretofore been recognized.

Laboratory of Bacteriology and Hygiene, June 15, 1905.

SOME BACTERIAL DISEASES OF PLANTS PREVALENT IN MICHIGAN.

WALTER G. SACKETT.

[Bulletin No. 230.]

I. Pear Blight.
II. Bacteriosis of Beans.
III. Black Rot of Cabbage.
IV. Wilt of the Cucumber, Muskmellon and Squash.
V. Soft Rot of the Sugar beet.
VI. Blight of the Irish Potato, Tomato and Egg Plant.

PEAR BLIGHT (FIRE BLIGHT).

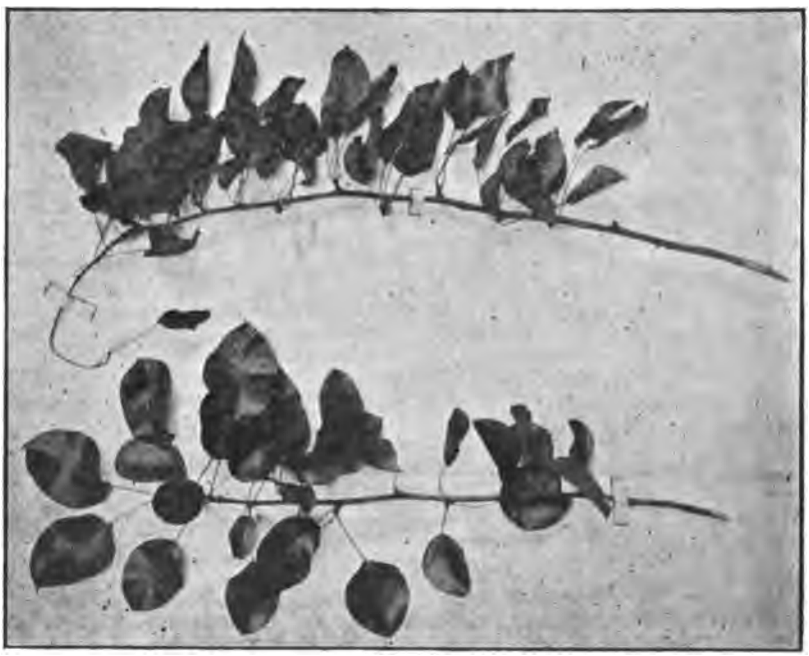


FIG. 1.—Two Pear Twigs; the upper one affected with Fire Blight, the lower one healthy.

Of all the diseases which affect the pear, there is none which is so universally dreaded by fruit growers as the pear blight. This disease is by no means confined to the pear alone but also infests the apple, quince, crab, mountain ash, service berry and several species of hawthorne; hence the blight can spread from one kind of a tree to another.

The name *fire blight* is especially good because it is at once suggestive of the symptoms of the malady. To one not familiar with the disease, it can be recognized at first sight by the brown and subsequent blackened appearance of the young leaf tufts and flower clusters; the young twigs show a blackened, shrivelled bark resembling very much green brush which has been only partially burned.

The blight makes its appearance early in the spring shortly after the blossoms have fallen and working rapidly back from the blossom clusters, an inch or more a day, soon involves the tender succulent twigs and ultimately the whole limb. If the diseased wood be cut off with a sharp knife, a dark ring between the bark and the wood will usually be seen. This is a further indication that your tree is affected. As the disease progresses and the smaller limbs show the infection, the bark cracks and a thick, black, sticky gum exudes; soon afterwards the bark becomes dark colored, hardened and shrunken. When the leaves fall in the autumn, the diseased parts of the tree are left very conspicuous by the dead leaves hanging to the twigs. If the blight attacks the larger branches

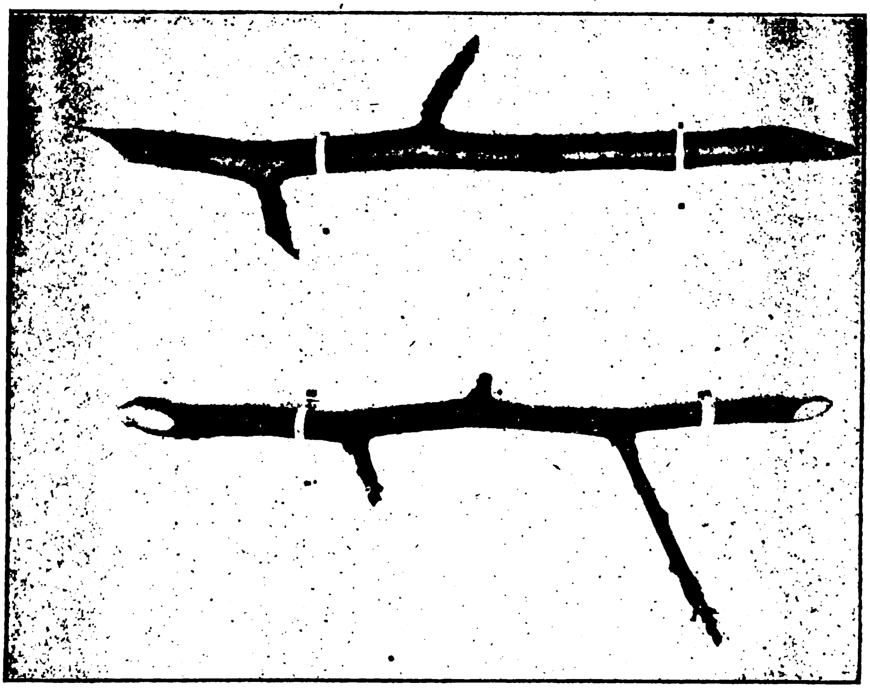


FIG. 2.—Pear Twigs. The upper one shows the smooth bark of a healthy twig. In the lower one note the dried up, shrivelled appearance caused by the Blight.

and trunk where there has been some mechanical injury or bruise, the symptoms are much the same as what is known as sun burn or sun scald. This form of the blight is known as rough bark or body blight.

In some of the most susceptible varieties, it is not uncommon to see the whole tree blighted in a phenomenally short time, sometimes within ten days. Occasionally it assumes its most severe form just previous to the picking of the crop. The writer has one pear orchard in mind numbering some four hundred trees which showed but three or four badly infected ones up to the middle of August. 1904, but within three weeks after that, every tree in the orchard was suffering from a severe attack. The fruit had to be picked two weeks before time in order to prevent all from being ruined by the blight.

HISTORY.

The disease is by no means recent for it dates back to the time of William Denning who first reported the trouble from the Highlands of the Hudson in

1770. He described it fairly well and ascribed the cause to a borer in the trunk of the tree.

The oldest book on American Fruit Culture published in 1817 by William Coxe gives a very accurate description of the disease. From this early date up to comparatively recent times horticultural literature has been crowded with numerous extravagant theories of the cause of the blight. Even today we occasionally find men who hold to one or another of the old ideas. It may be interesting to know what some of these were:

1. Insects.*
2. Rays of the sun passing through vapors.
3. Poor soil.
4. Violent changes in the temperature of the air or the moisture of the soil.
5. Sudden change from sod to high tillage resulting in surplus of sap.
6. Effect of age.
7. Autumn freezing of unripe wood, which makes a poison destroying the shoots and branches the following spring.
8. Electricity in the atmosphere.
9. Freezing of the sap or freezing of the bark.
10. Fermentation of sap.
11. Absence of certain mineral matters in the soil.
12. Something in the air which is carried from place to place.
13. Fungi.

ORIGIN AND SPREAD.

In 1878, Prof. W. T. Burril of the University of Illinois, succeeded in finding a kind of bacteria which he believed to be responsible for the disease.

The blackened twigs and sticky exudate were found to be alive with germs which are very small plants, so small, in fact, as to be seen only with a very powerful magnifying glass such as we find in the compound microscope. Some idea of the size can be gotten when you know that it would require 25,000 germs placed end to end to make one inch.

By taking some of this gummy material which contains the bacteria and inserting it into a healthy twig through a small cut, it was demonstrated that the inoculated twig took the disease and that therefore it could be spread from one tree to another or was what we call an infectious disease. It was also shown that this same gummy material from the pear could produce the disease on the quince and the apple. This experiment is very simple and can be tried by anyone who is interested in the infectious nature of the blight. It was argued by some that it was not the germs which produced the blight but rather the gum which was injected. To meet this objection, the germs were grown in a suitable medium such as beef broth and a quantity of the pure organisms were inoculated into a healthy twig. The results were very conclusive for the twig soon died showing that the germs by themselves had the power of killing the plant.

The question which we now have to answer is, where does the blight originate when our orchards have never had it before? Where does it come from? It has been shown quite conclusively that it is not carried on the wind, neither is it traceable to the soil. Insects and especially bees have been seen feeding on the gummy material which runs out from the cracks in the diseased wood and knowing that this exudate contains millions of germs, it is only reasonable to believe that these insects carry the disease on their feet and bodies to the healthy trees. Alighting on a delicate flower cluster, they crawl deep down after the so called honey or nectar in the blossom and here many of the blight germs are brushed off and left in contact with the tender blossom. Through these honey ducts or nectaries the bacteria gain entrance to the plant. Once favorably situated, they multiply very rapidly and move down the twig between the bark and woody cylinder through the growing layer, known as the cambium layer, which is familiar to everyone as the region from which the annual rings arise. It is in this way that a large percentage of the cases originate. Again the germs may gain entrance into the tender shoots through insect bites in the bark for although the opening may be no larger than a pin prick, myriads of bacteria can find a temporary dwelling place in this wound and may soon spread through the whole member. Lastly, the infection may enter the large limbs and trunk of

* Bulletin 136 Ontario Department of Agriculture.

the tree by some scratch or bruise in the protecting bark which has exposed the susceptible growing layer beneath to the visits of germ laden insects.

Thus we see that pear blight is caused by a germ to which the name *Bacillus amylovorus* (Burril) has been given, the meaning of which is starch destroying. We see that it is spread from one tree to another by insects, especially bees, and that the germs may gain entrance into the plant in any of three ways: First, and most important, through the blossom; second, through insect bites in the tender shoots; third, through mechanical injuries to the bark of the limbs and trunks of the trees.

CONDITIONS FAVORING THE DISEASE.

Although the knife is our only hope of exterminating the blight, there are undoubtedly conditions which favor the disease.

It is a matter of common observation that climatic conditions have a marked influence; warm, moist weather with a large amount of rainfall favors it, while bright, dry, cool weather tends to check it. That is, the former conditions are advantageous to the growth of the germs while the latter are unfavorable.

High cultivation, rich soil, heavy manuring, the use of large quantities of commercial fertilizer containing a great deal of nitrogenous material and heavy pruning all tend toward the growth of tender, succulent shoots. It is in this sort of plant tissue, gorged with sap, that the blight germs can grow and multiply most rapidly. Biting insects whose mouth parts are contaminated with the casual microbes, are most partial to these juicy shoots and leaves and their bites often serve to infect the tree.

It is evident, then, that vigorous, healthy, rapidly growing, too well cared for orchards are more liable to the disease than others and since these are factors which the grower can control, it is he who must strike the happy medium which will not permit the trees to suffer and yet will not give ideal conditions for the development of the germs.

PREVENTION AND TREATMENT.

The treatment of fire blight is of two kinds—the one, preventative, which aims at making the tree resistant to the attacks of the disease; the other, curative, which is intended to exterminate the harmful microbes and thus prevent their spread.

(1) It is obvious that if we are to render our trees resistant to blight, we must avoid those conditions which increase the predisposition to the disease. We have already mentioned the most potent factors in the propagation of blight as high cultivation, rich manures, commercial fertilizer high in nitrogenous material, excessive soil moisture and high pruning. In short, anything which favors the rapid growth of tender, succulent shoots should not be practiced. It is understood, of course, that these suggestions are not to be followed without reason or the trees will suffer from troubles other than the blight. The trees should be allowed to ripen their wood and to this end the grower must use some means which will limit the moisture in the soil. It is recommended that some good cover crop such as oats be used for this purpose.

(2) With a disease working as this does in the juicy part of the stem between the bark and the wood, there is no chance of reaching the trouble by means of sprays for unless the chemicals come in contact with the bacteria, spraying is futile.

The knife and saw remain as the only effective remedies. We must cut out and burn all affected twigs, leaves and branches not only from the pear but the apple, quince and related species as well, so that there will be no infectious material near by for bees to carry into the blight free orchard. It is very essential in cutting out the diseased branches to cut well below the discolored part as the bacteria are usually far below this region, the discoloration not appearing until after the bacteria have been at work some time, so that even if all the blackened wood were removed the seat of the trouble would not have been reached, and the germs would live on in the apparently healthy stump, soon to cause another visible outbreak of the blight. The affected branches should be cut back all the way from ten to fifteen inches below the discolored wood and if the branch be a large one, more than one-half inch in diameter, the cut surface should be

protected from wound rots by painting. Either lead and oil paint or shellac wash* or grafting wax may be used for this but the lead and oil paint is cheaper and less liable to crack than the others when exposed to the sun. The question may be asked, "When is the proper time to do the cutting?" The writer would answer, "Whenever the blight appears." Trimming out the diseased parts may be done at any time in the late fall, winter and spring. The most favorable time, however, is in the autumn after the leaves have fallen for then the blighted twigs become very conspicuous by the dead leaves still hanging to them. It is not advisable to postpone the cutting until the growing season, for at that time there is great danger of overlooking new cases which are constantly occurring owing to the lack of development so early in the season. If the entire tree is affected, there is little hope of saving it and the best procedure is to grub it out and burn the whole tree. Too much stress cannot be laid upon the complete destruction of the diseased wood for our only hope of stamping out the blight lies in removing the source of the infection. A single twig left on the ground unburned may mean the loss of the whole orchard.

The knife and the saw used must be sterilized after each cut in order that the disease germs clinging to the instruments may not be carried to the healthy parts of the tree. This can be done by passing the knife several times through a flame or it may be dipped into a 5 per cent solution of carbolic acid.

A careful inspection of the orchard should be made in the winter and spring before the blossom season in order to destroy any new cases that may have developed since the previous examination.

The greater part of the blight will be eradicated by one careful winter and spring cutting and if this be done and done thoroughly, the disease can be entirely controlled.

SUSCEPTIBILITY OF DIFFERENT VARIETIES.

So far as we know at the present time there are no varieties that are entirely immune to the disease. Several have been reported by growers as showing a greater power of resistance than others, among which may be mentioned the Duchess, Kiefer, Seckel, Anjou and Anjouleme. The more susceptible varieties are the Flemish Beauty, Clapp's Favorite and Bartlett.

Among the apples, the crabs in every case seem to take the disease most readily, but even here there are some which are freer from blight than others. It has been observed that the same variety in different localities and under different climatic conditions will exhibit different degrees of resistance. The Colorado Experiment Station† cites one case in a certain locality where Martha and Whitney crabs were grown alternately. The Whitney trees were either all dead or dying while not one of the Marthas was affected. However, in other localities the Marthas had succumbed to the blight.

In selecting trees, be guarded by local experience and choose the varieties which have done best in your locality.

BACTERIOSIS OF BEANS.

Frequently the foliage, stems and pods of the common beans as well as the Lima bean are preyed upon by a bacterial disease‡ known as Bacteriosis. The symptoms are such as to make it readily distinguishable from all other maladies to which the bean is heir.

There appear on the different parts of the plant, especially on the leaves, large, watery, brown patches or blisters that soon dry up and cause the tissue to become brittle and to curl leaving the foliage ragged and good for nothing. The pods seem to furnish the best food supply for the microbes and it is here that we find the disease at its best. Small discolored spots appear at first which spread very rapidly and produce large lesions with pink or reddish brown borders

* The Connecticut Exp. Sta. recommends oil shellac, to which is added a little flowers of sulphur and a few drops of carbolic acid.
† Bulletin 41 Colorado Experiment Station.
‡ Pseudomonas phaseoli (Smith.)

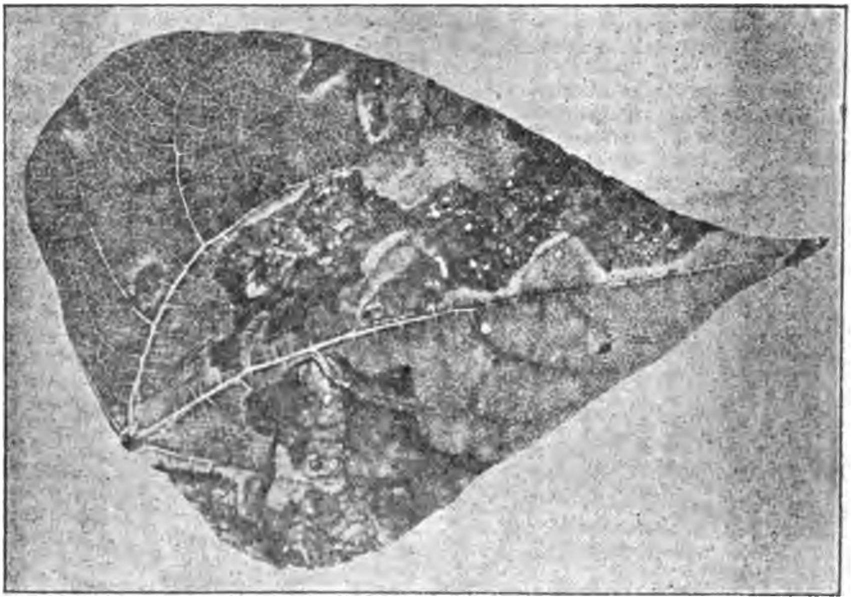


FIG. 3.—Bean Leaflet, showing Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

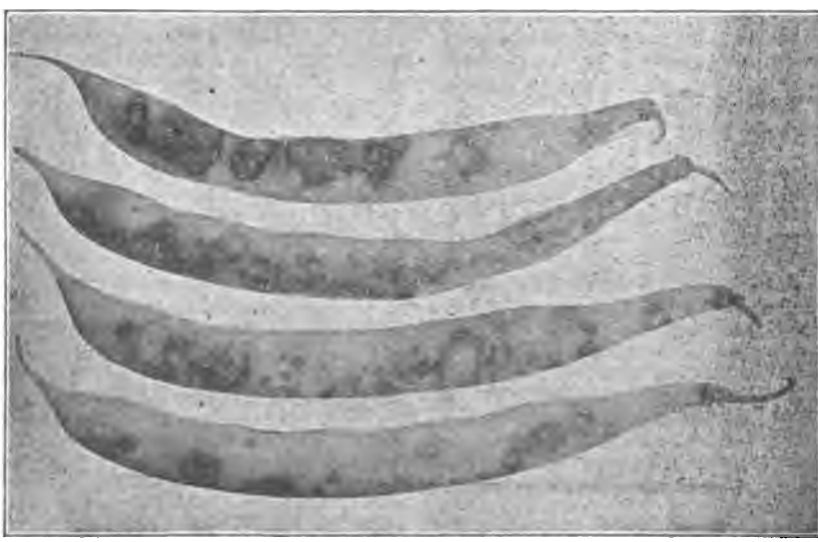


FIG. 4.—Four Bean Pods with Bacteriosis. (Halsted. New Jersey Station Bulletin No. 151.)

and having pale yellow or amber colored crusts over the affected areas. This crust is due to the accumulation of myriads of amber colored bacteria which have formed a layer over the broken down tissue. After a time the pod rots and the beans are worthless.

Warm, wet weather seems to favor the disease for the germs grow best under these conditions and the beans at the same time produce more succulent growths which are more readily attacked. Rain and dew are doubtless agents in spreading the germs from one part of the plant to another by washing them from old lesions onto unaffected parts. Insects play an important part in disseminating the trouble, consequently any measures which tend to check these pests will aid in controlling bacteriosis. The distribution of the disease is further effected by dead vines and leaves carried on the wind; by the soil and through the seed. New land which has never grown beans seems to be freer from the disease than old and should always be used when available.

The seed used in planting should be selected by hand and all the lighter ones discarded for Gain* reports that anthracnosed seeds are less dense than sound ones. As yet no satisfactory method has been found which can be recommended for treating the seed to destroy the casual microbe which does not lower the viability of the seed.

Inasmuch as the germs of bacteriosis work on the outside of the plant, it is possible to reach them with a fungicide and spraying with Bordeaux mixture* upon two and three inch plants followed by the same ten days later and again after blossoming.† Dr. Halstead uses a Bordeaux mixture of the following strength: Copper sulphate, 6 lbs.; lime, 4 lbs.; water, 60 gals.

Variety tests conducted by the New Jersey Experiment Station during the three years 1897-1899 with Green Flageolet, Currie's Rust-proof, Early Mohawk, Golden Wax, Extra Early Refugee and Saddleback Wax showed the Green Flageolet, the most susceptible, and the Early Refugee the least.

BLACK ROT OF CABBAGE.

The black rot of cabbage is to the truck producer what pear blight is to the fruit grower; in fact, it may be considered far worse, for on the one hand there is only the loss of the crop while on the other not only is the cabbage destroyed but in addition the soil on which it has been grown is so inoculated that it is practically useless to attempt to raise the same crop on the same field with any degree of success for a number of years.

Bacterial examination of diseased plants has shown the sickness to be due to a kind of germ.‡ The disease is by no means confined to the cabbage but attacks other cruciferous plants such as cauliflower, collards, kohl rabbi, kale, brussels sprouts and broccoli. It has also been reported as occurring in turnips, rutabagas, wild radish and mustard. It is widely distributed in the United States, having been found most prevalent east of the Mississippi River. In 1891 Prof. W. Paddock reported it from Colorado. Previous to 1899 we do not hear of the black rot in Europe but the investigations of Harding,§ confirmed by foreign workers, show the disease to be wide spread and of long standing. England, Holland, Denmark, Austria and Switzerland are mentioned as constant sufferers from the malady. This is peculiarly interesting, since a few years back a great deal of our cabbage seed was imported from Holland and Denmark. The comparatively recent discovery of the infection in Europe is probably due to the better methods of diagnosing the disease than formerly rather than to recent appearance of the trouble. Cabbage growers of Europe have observed it for many years, it seems, but they were accustomed to associate the cabbage worm with the rot rather than the true bacterial cause.

The disease can be recognized by the dwarfed, one-sided growth of the plants and in some cases, failure to produce heads. Sometimes the head will rot and fall off

* Bulletin 151 N. J. Exp. Sta.
† Bulletin 121 Ohio Exp. Station.
‡ Pseudomonas campestres (Pannuel) Smith.
§ Cent F. Bakt. II. Ab. Bd. VI—305-313, (1900.)

but this is not a necessary accompaniment of the disease for this symptom together with the bad smelling head may be due to the work of other bacteria which are living on the tissue already weakened by the true black rot organism. In the early stage of the disease, the leaves show a withered, dried appearance along the margin followed by a yellowing in time. The small ribs that lead to the mid rib are usually blackened first and ultimately the larger ones and the mid rib succumb. On cutting across the stem of an infected leaf or sick stalk, one can see the blackened ends of the fibrous strands, known as the fibro vascular bundles,' which lead from the stalk out into the leaf and supply it with water and soil foods. A microscopic examination of these vascular bundles will show the tiny tubes of which they are composed to be alive with germs. As soon as these food and water channels are destroyed, the blade of the leaf is no longer able to get the subsistence required and dies. Diseased leaves usually fall prematurely, leaving a long naked stalk with a tuft of leaves at the tip. The old leaf scars will show the ends of blackened strands corresponding to the diseased fibro vascular bundles in the leaf.

FIG. 5.—Cabbages showing effect of artificial inoculation. Middle plant vigorous and healthy (uninoculated). Plants 1 and 3 inoculated with Black Rot germs. Note dwarfed, one sided manner of growth. Russell. (Wisconsin Station Bulletin No. 65.)

It has been found* that the most common method of infection in the field is through the very small water pores scattered over the blunt teeth on the margin of the leaf. It is by these water pores that a part of the soil moisture that is taken up by the root system escapes from the plant as water vapor but if the surrounding atmosphere is very moist, there will be no evaporation and the water will be seen to accumulate in tiny droplets just over the pores. However, if the soil is very dry, even though the air is moist, we do not have these water beads formed. They can be seen frequently in the early morning on the surface of the leaves and are frequently mistaken for dew. It must be borne in mind that the air is always filled with dust and numerous bacteria and among these there are almost certain to be the germs of black rot, especially if the wind is blowing over a sick field carrying with it fragments of rotting plants and infected soil. These germs are in the beads of moisture, referred to above, and finding a comfortable lodging place and abundant food and water supply, they multiply very rapidly and being able to move about, soon find their way down through the water pores into the veins of the plant. Here they continue to multiply and work toward the stalk, leaving behind them the blackened veins and withered blades. The germs may also gain entrance by means of the bites of gnawing insects and again by way of the broken roots at the time of transplanting.

* Bulletin 65 Wis.; Exp. Sta. Farmer's Bulletin 63 U. S. Dep't Agr.

FIG. 6.—Cabbage Leaf affected with Black Rot, Water Pore infection. (Stewart and Harding. New York Station Bulletin No. 232.)

There is no question but that in many cases the plants are taken from the seed bed in a diseased condition and when transplanted into the field spread the germs through the soil rendering it unfit for cabbage growing in the future. When the source of the infection is confined to such a limited space as the seed bed, it is possible to sterilize the soil to depth of five or six inches by covering it with brush and cord wood and burning it, the heat produced penetrating sufficiently deep to kill most of the surface bacteria as well as troublesome weed seeds. This is a very common practice with tobacco growers and has met with great success wherever employed. If this is not practicable, the seed bed should be located in a new place each year and where cabbage has never been grown. It is only reasonable to suppose if your plants are in a good vigorous condition when transplanted into a "healthful" field, their chance of living is vastly greater than if sick from the start.

When stable manure is used for fertilizer, every precaution should be taken to keep infected cabbage refuse from getting into the manure for in this way the whole heap will become infected with the rot germs and when it is spread on the field the entire plat will become inoculated. One of the worst plant disease epidemics on record was caused in this very way. The writer refers to the present watermelon wilt in North Carolina, South Carolina and Georgia, where melon growing for the past two years has been practically abandoned by the smaller producers because of the ravages of the wilt. The only safe way to dispose of refuse is to burn it.

It has been demonstrated experimentally by Harding,* Stewart and Prucha that the cabbage seed itself is contaminated with the black rot germs, that some of them could live over winter on the seed and become the source of infection to the young cabbage plants. They advise disinfecting the seed before sowing by soaking it in a 1-1000 solution of corrosive sublimate† for fifteen minutes or in formalin, one pound in thirty gallons.

The removal of sick leaves in the early stages of the disease is practiced by some growers with success. Others have tried this preventative and found it to be a complete failure. The recent investigations of Stewart‡ and Harding condemn this practice and prove quite conclusively that the method is not only harmful to the plants but also worthless. The treatment fails, they say, because

> "The removal of so many leaves checks the growth of the plants; infection occurs by way of the roots as well as through the leaves; infection may occur at the base of the leaf close to the stem and get into the stem unobserved; the germs of the disease are so widely and so abundantly distributed that it is useless to try to stamp out the disease by the removal of the diseased material."

Warm days, cool nights, and frequent showers seem to accelerate the rot. Smith§ is inclined to think that cabbage planted late is less susceptible than that which is planted early. In selecting cabbages for producing seed the following season, care should be taken to pick out only those which are absolutely free from the infection.

When cabbage is to be stored over winter, the heads should be examined critically and any diseased ones rejected or kept by themselves. The room or store house must be kept cool, below 40° F., and must have uniform ventilation.

It is a matter of common observation that when cabbage is grown year after year on the same piece of land, there is a notable increase in the amount of rot. In the first place, such a method is not to be recommended from an agricultural standpoint since it violates the important principle of crop rotation and further, if it becomes necessary, because of limited space, to continue using this land, our only hope of getting rid of the disease is to grow crops other than members of the cabbage family for five or ten years and longer. During this interim the land must be kept free from all cruciferous weeds which harbor the bacteria, especially from the common wild mustard.

If possible, cabbage should be set each year on ground which has not been planted to it for some time or which has been in sod several seasons or else cultivated to crops which are not affected by the rot. The one important thing for the gardner to observe if he would be a successful cabbage grower, is to take the utmost care to keep his field from becoming infected, and if once infected not to spread the malady over his whole farm.

WILT OF THE CUCUMBER, MUSKMELLON AND SQUASH.

This disease of the Cucurbits does the most damage early in the season when the vines are just beginning to run. Sometimes, however, seedlings succumb to the infection while again the wilt does not appear until the vine is in full bearing. Such an instance was observed in the cucumber forcing house at the college this spring. The vine was apparently healthy and doing well when suddenly the leaves began to wilt as if from lack of water or too much hot sun.

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* Bulletin 251, N. Y. Exp. Sta.
† Corrosive sublimate, 1 part: hydrochloric acid, 2 parts; water, 1000 parts.
‡ Bulletin 232, N. Y. Exp. Sta. (1903).
§ Loc. Cit. pp. 12.

There was no drying or shriveling of the leaves and in two days the plant was dead. A microscopic examination of a cross section of the vine and larger roots showed the vascular bundles to be plugged with bacteria. No fungi were found and there was no indication of insect work on the roots.

The writer has observed the same wilt on the muskmelon. The symptoms here are the same as for the cucumber as are also the symptoms for the squash; sudden wilting as from lack of water caused by the clogging of the watertubes, followed by prostration and death. Usually one runner will die at a time, beginning at the tip and working back toward the root. Growers seem to think the wilt is worse during wet weather and just after a heavy rain, especially if the sun comes out very hot. Spraying is useless and preventative measures suggest pulling up the sick vines and burning them. The suggestions given for the prevention of potato blight will apply here also. Plant on new land as far as possible and avoid the use of fields which have shown the infection. Rotation of crops is also advised.

Smith* ascribes the wilt to a bacillus† which he believes is carried from diseased to healthy plants by the cucumber beetle and squash bug, hence the necessity of destroying these insects.

SOFT ROT OF THE SUGAR BEET.

This disease was first described and the specific germ‡ isolated by Metcalf and Hedgcock§ in 1902. Beets affected with the rot show the lower half badly decayed and the rotten part honeycombed with "pockets" or cavities filled with a slimy, stringy fluid, colorless and sour smelling. The vascular bundles remain intact while the tissue surrounding them is usually consumed. The normal color of the beets differs so that it is difficult to give any hard and fast color characteristic, but when affected the tissue first shows a yellow, changing to a clay color or gray; later these colors gradually darken. In some cases beets that are badly rotted show no discoloration while others in the early stages are very dark. Above ground the beets appear normal.

A microscopic examination of viscid liquid that fills the cavities of the rotting tissue shows millions of bacteria, which when grown later in pure culture and inoculated into healthy beets produced symptoms typical of the disease.

The germs gain entrance into the beet through wounds and abrasions in the skin and there is good reason for believing that nematodes are responsible for many of the inoculations. So far as experimental work goes, there is no evidence that infection can take place except through cuts or scratches in the outer surface of the root. In the field, the disease has been observed to progress most rapidly under warm and wet conditions; more mature beets are affected more severely than the younger ones, probably due to the larger amount of sugar present.

If the beets are stored in silos and rotting sets in, they should all be inspected and the decayed ones put in a pile by themselves so that all will not contract the rot. Cold storage does not seem to have any influence on checking the trouble, for even at low temperatures the germs continue to grow and produce havoc. It is recommended|| that beets from sick soil be thoroughly sunned and dried before storing, inasmuch as the desiccation and sunlight have been found to be very detrimental to the growth of the germs.

Prevention is the only remedy that can be suggested at this time. Grow your beets on relatively dry ground, if possible and plant corn or some other suitable crop on your former beet ground where the excess of moisture can do no harm. Our greatest hope of controlling this disease as well as others is by breeding up some resistant variety and by careful selections secure a strain which can be planted on wet land and yet remain immune. There is no question but that such resistant varieties will be forthcoming in the near future now that the scientific world is so wide awake to the wonders of plant breeding.

* Proc. Am. Asso. Ad. Sci., 1895, pp. 190.
† Bacillus tracheiphilus (Smith).
‡ Bacillus teutlium (Metcalf).
§ Seventh Annual Report, Neb. Exp. Sta. (1904).
|| Cent. f. Bakt. II Ab. Bd.VII.—1 & 2.

BLIGHT OF THE IRISH POTATO, TOMATO AND EGG PLANT.

It has been shown* by Dr. E. F. Smith that a single species of bacteria† has the power of producing blight in a number of plants of the potato family. Among the cultivated ones may be mentioned the Irish potato, tomato, egg plant and pepper. Several common weeds such as the horse nettle, jimson weed and ground cherry are also susceptible to the disease. However, we are especially concerned with the disease as it occurs in our common garden vegetables.

The blight manifests itself in the vines by a sudden wilting either of a part or the whole. The stems usually wither, turn yellow and finally black. Young plants appear to contract the disease more readily than old ones. By cutting across the affected stem one can see the characteristic brown or black woody tissue in which the bacteria are at work. The tubers from sick plants show a distinct ring of discolored tissue a short distance from the outside of the potato.

Fungicides are of no value in treating the disease and prevention is the only remedy. Do not use diseased tubers for planting and avoid planting on potato sick land as well as on land which has had diseased tomatoes or egg plants.

The symptoms of the blight in the tomato and egg plant are much the same as those for the potato. The vines wilt as if suffering from too hot sun or lack of water. Decay of the stems and branches soon sets in, resulting in the destruction of the plant.

Here, too, spraying has been found useless, for the cause of the disease is deep seated within the tissue and beyond the reach of any germicide. Insects, undoubtedly, play some part in carrying the germs from plant to plant and thus spread the trouble, but the soil seems to be the principal medium of infection. What has been said in connection with the potato may be said about planting tomatoes and egg plants on land that has had diseased specimens of the potato family.

If the disease is not too general, it is possible to control its spread by removing the dead vines with the roots from the field and burning them. It is of utmost importance that the vines be destroyed and not thrown down carelessly to start the disease in a healthy part of the field. Remember that you are dealing with a contagious disease and it is your duty to keep it from spreading. One sick vine in your field this year may mean the loss of half your plants next year. Numerous cases have been reported where soil diseases have been carried from farm to farm, up and down the road by the infected mud that adheres to the wagon wheels. The greatest care should be exercised in plowing and cultivating not to drag sick vines over healthy soil for by so doing the disease is spread and what might have been a mild attack is aggravated to such a degree that a general epidemic results. Tools should be thoroughly cleaned before going from an infected field into one free from the disease and as a further precaution, they should be disinfected by washing or dipping them into a 5% solution of either carbolic acid or copper sulphate, commonly known as blue stone. It is important that the gardener's shoes as well as those of his horse be free from clumps of infected soil before going into a new field.

There is a common practice among some farmers of hauling the soil that has washed down a hillside back up onto the shallow places of the farm. If this is done, one should be very certain that the hillside from which this soil has washed is free from all plant diseases, for the writer is familiar with several instances where infection has been spread over healthy land in this way.

Where no remedy can be given, it is clear that our only hope of controlling a disease is by preventing its spread. By observing the foregoing suggestions, it is believed that the most serious plant disturbances can be entirely prevented or at least controlled.

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* Bulletin 12 Div. Veg. Path. U. S. Dept. of Agr.
† Bacillus solanacearum (Smith).

NOTE.

It is earnestly desired that the farmers and gardeners of the State of Michigan will coöperate with this department in furthering the study of bacterial plant diseases by reporting all diseases of this nature that may come under their notice and also by sending in specimens of suspicious material for examination. Wherever possible the whole plant should be sent, for usually root, stem and leaf are required for a satisfactory diagnosis. Address all of your communications relative to suspected bacterial plant diseases to The Department of Bacteriology and Hygiene, Michigan Agricultural College, Agricultural College, Mich.

SUGGESTIONS CONCERNING LEGUME INOCULATION.

LAWRENCE T. CLARK.

[Bulletin No. 231.]

The soil of many farms in Michigan, as well as in other states, especially in the older states, is becoming depleted, and among the exhausted elements nitrogen is one of the most difficult to recover. The principal means of recovering nitrogen to the depleted soils are: First, the application of barnyard manure; second, the use of commercial fertilizers; third, the growing of leguminous crops, which, if infected with nitrogen-fixing bacteria, take nitrogen from the atmosphere and store it within the plant. The supply of barnyard manure is inadequate to make up for the losses of nitrogen occasioned by ordinary cropping; the supply of the mineral salts of nitrogen contained within the commercial fertilizers is rapidly becoming exhausted, hence too expensive to be used with profit; finally, this brings us to the growing legume, the nitrogen-fixing bacteria, and the atmosphere as a feasible solution of this serious question.

Since 1884 to 1886, it has been definitely known that legumes, possessing nodules on their roots, have the power to take nitrogen from the atmosphere and make use of it in the actual growth of the plant. Plants possessing these nodules or an internal infection without the formation of nodules, were found to be the only ones capable of this action. The organism or germ present within the nodule and root was found responsible for the formation of such enlargements, and also for collecting and transforming the nitrogen into an available form.

Owing to the fact that these nodules would form only in soils infected with the nodule producing organism, it is impossible to grow legumes, possessing such nodules, in soils where that particular legume or one closely related, has not been previously grown and the proper organism distributed. However, a complete inoculation is made possible by a persistent seeding of one field to the same legume. The nodule-forming bacteria are carried in small numbers on the seed from their respective hosts, consequently, by the application of one kind of seed to the same field year after year a quantity of the germs is distributed, which, together with those which have already developed on the host of the previous season's planting, finally succeed in affecting a uniform inoculation over the entire field. This manner of securing a successful inoculation, although a rather long and expensive one, has proved itself a certain one in several cases that have been called to our attention.

The effect of a previous successful inoculation, although upon a different species of legume, is coming to be considered beneficial to the succeeding legume. For example, a thoroughly inoculated plot of vetch was ployed under at the College Experiment Station in May, 1904, and the plot sowed with uninoculated alfalfa. In May, 1905, this same plot was again plowed up, exposing the alfalfa roots which were heavily laden with clusters of nodules not unlike the typical vetch nodules. Another interesting feature of this observation was the existence

of these clusters not along the stem, as is usually true with alfalfa nodules, but at about the depth of the first plowing and on rootlets running out to a considerable distance from the main root. This is only one of several instances noted that suggests that some benefit is to be derived from one legume following another.

Soil, taken from a field upon which nodule-laden legumes had been grown for some years with success, was first used as a means for distributing the proper organism. This method usually proves very satisfactory from the standpoint of securing the required inoculation, but it has its objectionable features. The expense incurred in shipping and applying sufficient quantities of the germ-laden soil to secure thorough inoculation is often high and the true germ content of such soil is often questionable. These objections, however, are counteracted to quite an extent by the effectiveness of the method. It is still being employed and is serving at present as well as any method.

In 1898, Nobbe conceived the idea that inoculation might be brought about by using pure cultures, grown upon an artificial medium. He put his idea into practice and sent out cultures of the organism isolated from each kind of legume. These cultures were distributed in bottles on a nutrient medium. The use of these cultures in Germany gave many favorable results. A new field had been opened, a broader field, perhaps, than scientific men at that time realized. Tests with his cultures were also made in the United States, with a less degree of success than had been met with in Germany, but it failed to receive general support because of the questionable results.

It was not until the work of Dr. George T. Moore of the Laboratory of Plant Physiology, Department of Agriculture, Washington, was given to the public that general interest in this subject was again aroused. The material previously mentioned, sent out by Nobbe of Germany, was a culture grown and distributed upon a nutrient agar containing nitrogen. Dr. Moore aimed to cultivate the organism on a nitrogen-free medium and by so doing claims to have succeeded in developing a culture that is possessed of greater vigor, both in producing the infection and in storing up free nitrogen. The cultures prepared in this way were distributed to a large number of farms throughout the United States and the results obtained by their use upon seed, given in Bulletin No. 71, Bureau of Plant Industry, show successful inoculation and increase in productiveness in 76 per cent of the cases tried, barring a large number of cases reported as failures due to unfavorable conditions, including poor seed, poor seasons, weed growth, etc.

Closely following the apparent success achieved by Dr. Moore's cultures, several commercial establishments placed inoculating material upon the market. The merits of such cultures have not been established and they are not controlled by the Government, consequently their real value is unknown. The person who invests in such cultures is doing so entirely at his own risk—is taking a leap in the dark; by paying a large price to try an experiment in which the actual possibilities of gain have not been firmly established, he renders himself subject to utter failure as well as possible success.

Inoculating material, without question, will produce the desired infection when applied under favorable conditions. What these favorable or unfavorable conditions are, we are unable to indicate satisfactorily, for it should be remembered that although ideas are formulating, we are still in the first stages of the work and it would be presumptious to establish fast lines and binding conditions. Such application of inoculating material, from an experimental standpoint, in pots under glass and in small plots in the field, can be carried out very successfully and very flattering results are obtained. Naturally enough, workers are led to expect similar returns from their efforts when directed to larger areas and in a practical way, forgetting the number of unknown conditions which creep in. It is difficult also to determine whether fields require these inoculations or not, since not only the constituents of the soil, the weather elements, and drainage enter for consideration, but the very history of a field must be consulted. The idea in mind when legumes are sown is to increase the fertility by adding nitrogen and humus, and this can be done only by conforming to the controlling influences concerning which we are in such dense ignorance.

In Table II of Dr. Moore's Bulletin No. 71, where "Reports of Experiments with the Principal Leguminous Crops" are given, we find one column, No. 3,

which contains, "Failures definitely ascribed to bad season, poor seed, weed growth, etc." Out of 2,502 reports upon alfalfa, red clover, garden pea, common bean, cowpea, soy bean, hairy vetch, crimson clover, field pea, velvet bean, alsike, sweet pea, and berseem, 574 were failures due to the above named causes, while 339 showed no evident advantage from inoculation. From a practical standpoint the failures, of whatever nature, should be considered as such in denomstrating to the public what the real values of this inoculating material are. On the other hand, when we can tell with precision the exact conditions under which inoculating material will prove successfully effective, we shall have solved the question in as satisfactory a manner as we now hope to be able to do. Our efforts, at present, are directed along this line with this end in view.

Through the results published by Dr. Moore in Bulletin No. 71, and from popular articles appearing in agricultural papers and journals, much injudicious enthusiasm has been aroused in this matter which portends trouble for the agricultural public through no fault of its own, because it is in no position to interpret these articles correctly. Information of this character given out to these eager rural peoples by overzealous progressive writers is of a nature to be severely criticised. Exaggerated and misleading articles have appeared, based entirely upon results obtained from limited conditions. The effect of such statements has been very annoying and perhaps detrimental to the subsequent solution of this yet perplexing problem. A still more serious effect, perhaps, is that the expectations of a less conservative rural public are wrought up to such a pitch as to look for results entirely beyond reason, and to regard it as a panacea for all crop failures. This is due in a certain degree to a lack of knowledge of the real powers of these micro-organisms and their limitations.

It is essential to bear in mind that the use of inoculating material as a means for definite gain is in the experimental stage only. Practically all the results upon which we can base any stress are confined to limited efforts during a very brief period. Until this work has been confirmed and the conditions for manipulation, control, and growth learned, both favorable and unfavorable results must be expected and judgment suspended.

As implied, the enthusiasm created by various misinformed writers has led the farmer to expect too much from the use of inoculating material from whatever source it may be obtained. It is our purpose to caution against undue haste in the matter unless farmers are willing to look upon it as an experiment rather than something established. With this end in view, plots have been secured in different sections of our State, on representative soils, to be used for determining the efficiency of pure cultures of the nitrogen-fixing organism in connection with legumes. Inoculated and uninoculated seeds of alfalfa, June clover, soy beans, and cowpeas were sowed on these plots and results favorable or otherwise will be looked forward to with great interest.

Along this same line Director C. D. Smith, who initiated this work at the Station, is continuing with experiments in testing inoculating material from different sources, different methods of inoculating, in fact, covering many practical phases of this work and he, with F. W. Robison, has already embodied very valuable results in Bulletin No. 224, in which is discussed among other things, the effect of inoculation upon the chemical constituents of the mature plant.

With the combined efforts of Professor Smith and the workers in this department, and also the work carried on elsewhere, results are looked for in the near future that will enable us to say more definitely under what conditions and to what extent we can expect inoculating material to be beneficial.

Many requests for the coveted inoculating material were received early in the winter of 1905. These demands made it necessary to take the matter up at once and if possible determine for the benefit of the farmer, as well as for ourselves, the advisability of distributing inoculating material.

The work of isolating and cultivating these micro-organisms was begun early in January and cultures to be used later upon seed for the field were developed as directions indicate in the following technical portion of this Bulletin. Facts concerning the life history of these micro-organisms may prove beneficial to the farmer in his manipulation of the germs and in understanding their nature.

To secure a culture of this organism free from contamination, the following methods are employed by the writer:

Method No. 1.

I. Wash nodule free from soil.
II. Place in a 1:500 solution of acid mercuric chloride for two minutes.
III. Rinse in sterile water and dry between folds of sterile filter paper.
IV. Hold nodule with flamed forceps and cut upon with flamed knife edged platinum needle.
V. Make transfer with flamed straight needle to melted media.
VI. Make two single loop dilutions from original transfer tube and plate. Set plates in temperature room at 25° C., if possible.
VII. After colonies appear (24-72 hours) isolate organism from characteristic branched colony to slant tubes and into liquid media. Note—The characteristic branched colony will predominate over any possible contaminations in plates.

Method No. 2.

To be recommended when nodules are very small. Wash, sterilize, rinse, and dry as in I, II, and III, Method No. 1.
IV. Place nodule between flamed one-half cover slips and press slips firmly together.
V. Transfer these slips into tube of melted media and break them apart with sterile platinum needle.
Make proper dilutions, grow, and isolate as in VI and VII, Method No. 1.

Both methods have been found, in our work, to be very satisfactory in isolating a pure culture.

The final step is to establish the supposed identity of a culture thus isolated. To do this, we employed the following method:

Seedlings of the species of Leguminosae from which the organism in question was isolated, were grown in sterile quartz and watered with a dilute sterile soil solution. As soon as the first pair of leaves were formed, a 24-hour liquid culture of the isolated organism was poured about the stems of seedlings in one pot; a second pot, without pure culture, being kept for control.

If culture is true to name, nodules will appear within 14 days after inoculation.

In our work, better results were obtained when nodules were collected from nearly mature plants. The reason for this is not determinable at present with us. After the circulation in the plant ceases, the centres of the nodules rapidly break down into a doughy mass, hence the necessity for collecting nodules for future use, before this stage is reached, becomes apparent.

Special culture media best serve the purpose for cultivating this organism satisfactorily, although it will grow well on nutrient agar and in bouillon. Various combinations have been tested by Mr. H. F. Tuttle and myself, the following proving most satisfactory:

I. Extract 450 gr. beef with 1000 cc. lime water.
II. Strain out meat and boil extract down to 500.
III. Add 1% peptone and dissolve.
IV. Add 1½% agar predigested in 500 cc. distilled H^2O.
V. Establish acidity at 8°+, cook one hour, and filter. Tube and sterilize.

Two per cent glucose added to this medium permits a more rapid growth, but a fermentation takes place in slant cultures and interferes with a characertistic growth. One other, however, gave good results, and might well be mentioned:

Ordinary beef extract	1,000.0 cc.
NaCl	5.0 gr.
$MgSO_4$	0.1 gr.
KH_2PO_4	0.5 gr.
Maltose	15.0 gr.
Agar	15.0 gr.
Acidity established at	8°+

Although the beef extract used in this formula contains approximately .11% N, this amount is considerably lower than that in media to which peptone has been added as a nutritive element, consequently this medium comes nearer to the class of nitrogen-free media than the previous one, which contains peptone.

When a culture is desired for securing inoculations upon soil or seed, the organism should be isolated from the plates at once to a nitrogen-free nutrient solution, where growth takes place more slowly, but where the nitrogen assimilating power is retained and increased, according to Moore. Among a number of nitrogen-free preparations tested, solutions A and B as follows, gave the most luxuriant growth:

Solution A—

Glucose	36.21 gr.
$MgSO_4$	.18 gr.
KH_2PO_4	3.62 gr.
Tap water	1,000.0 cc.

Solution B—

Glucose	10.0 gr.
$Mg(PO_4)_2$	.5 gr.
Tap water	1,000.0 cc.

The range of temperature at which this organism will grow is quite wide, being from 7°C. to 38°C. 25°C., however, is the temperature best suited to a luxuriant, characteristic development. Above 25°C. very rapid drying out of the culture takes place. This is especially marked in slant agar cultures where a wrinkling of the growth also ensues, which interferes with the development of branched forms and also with the vitality of the organism.

Variation of temperature, with absence of moisture, has little or no effect, however, upon the vitality of the organism when within the nodule itself. To establish this fact, a number of sound cowpea nodules were collected in October, 1904, washed sterilized with 1:500 $HgCl_2$ as for isolating, and then dried under sterile conditions. Three of these nodules of a uniform size were then selected and placed one each in sterile tubes numbered 1, 2 and 3.

A culture was made from No. 1, and motility, number, and cultural vitality of the organism noted. The remaining tubes, Nos. 2 and 3, were placed near steam connections at a temperature of 40°C. In 21 days No. 2 was tested in the same manner as No. 1, and after 42 days No. 3 was tested as were Nos. 1 and 2. The results of these tests showed that the constant high temperature had no apparent detrimental effect on the vitality, motility, and number of organisms present.

Parallel with the above experiment, cultures were grown on solid artificial media, in tubes, at a temperature of 37.5°C. for 21 and 42 days respectively. A heavy growth occurred which soon became dry and shriveled, and when transfers were made to fresh media at the end of 21 and 42 days, the organism made a slow, weak growth, possessing but little vitality. This weakened condition was remedied by making a series of transfers on fresh media at a temperature of 25°C.

The effect of freezing has not been fully worked out, but the following observation shows that the organism, when left within the nodule as it grew in the field, has considerable resistance to frost. On March 25, 1905, a nodule-laden root of soy bean was pulled from an inoculated experimental plot at the College. Some of these nodules were still intact, and contained a very active culture of the soy bean organism. The hanging drop revealed marked motility and plates made from the same nodule developed the characteristic tree-like colony.

The colony first appears as a small, round spot, which soon grows up through the medium to the surface. Upon reaching the surface, it spreads out at a very rapid rate, and takes on a peculiar characteristic tree-like form. If colonies are crowded in the plate, this characteristic growth is not so apparent and one might question the source of a thick plate, while the greater dilution plate would develop the colony true in character.

Because of the rapid spreading peculiar to this colony, fewer contaminations are met with if greater dilutions are made from the original tube which contains the nodular material.

Colonies from different species of legumes vary but little in general appearance.

Some minor differences exist, however, that can be detected only when a comparative examination is made. Those from the clovers are very similar, as are those of the cowpea and soy bean. Slight differences exist, however, between the colonies from these two classes.

After the organism is once isolated to artificial media, it is desirable to maintain and increase its vitality, if possible. To attain this end in our work, the organism was transferred to slant agar tubes of peptone-free media, and grown at a temperature of 25°C. for 48 hours. The tubes were then removed to a temperature of 16°-18°C. and allowed to remain. Under these conditions the culture remains fresh and actively vital for a much longer time than if grown in media rich in nitrogen at a higher temperature.

Associated with the old cultures grown as indicated above, we find the large rod and branched forms. The branched forms are peculiarly branching micro-organisms resembling the letters "T," "X," and "Y." In our investigations we have found these forms in old cultures only, and on media deficient in and entirely devoid of nitrogen. Their presence was demonstrated by making a series of stains from 1-15 and 30 day cultures, respectively. The 24-hour culture possessed the minute rod forms only. In the 15-day culture, several of the large rod and branched forms were present, with the minute rod forms in the majority. In the 30-day culture, the large rod and branched forms were quite numerous.

According to Moore, the assimilation of atmospheric nitrogen is attributed to the large rod forms which eventually become transformed into the branched forms, and in the nodule the branched forms only can be acted upon by the plant juices. Because of the close relationship between the occurrence of the large rod forms and branched forms, as demonstrated by our own work, it is questionable whether any distinct line can be drawn between the nitrogen-assimilating power of these two forms.

I have attempted to point out the requirements necessary for the successful cultivation and study of the organism in question. Although the work with this particular organism is in a very tentative stage, much is being done at present to determine its true economic importance. For success in practical field experiments, much depends upon the cultural manipulations in producing inoculating material. At present this work is progressing successfully in our laboratory, and we hope in the near future to say definitely what can be done with this organism nature has so fitly supplied to benefit leguminous plants.

Laboratory of Bacteriology and Hygiene, June 29, 1905.

INSECTS INJURIOUS TO THE APPLE.

BY. R. H. PETTIT.

[Special Bulletin No. 24.]

AFFECTING THE ROOTS.

The Woolly Aphis of the Apple. (*Schizoneura lanigera.*)

A plant-louse widely distributed and of very considerable importance; working on the aerial branches and on the roots, producing swellings, and impairing the health of the trees, beside often killing young trees outright.

This little creature which has gained the name of the "American blight" in the Eastern Continent because of its destructiveness, is a small plant-louse, either winged or wingless, and having the body covered with a delicate filmy wool-like coat which projects in a brush beyond the rear end of the body.

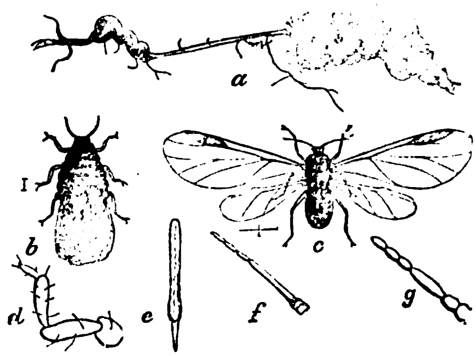

Fig. 1.—The Woolly Aphis of the Apple, from Riley, First Rep. State Entomologist of Mo.

They love to gather in numbers on wounds or in places where the bark has been cracked, or where a limb has been cut off and the healing process has commenced. Wherever they congregate there is a roughening of the bark. The aerial lice are seldom very serious but they indicate the probable presence of lice on the roots. The underground lice produce large, knotty swellings on the roots, seriously injuring young trees and often leading to their death. Older trees will stand these ravages much better, especially if well fertilized and cultivated. Trees attacked by these pests usually show that something is the matter by the foliage, which is less brilliant and not so plentiful.

REMEDIES.

The insect is already widely distributed in our state, but nevertheless it will pay to try to evade it. In setting out new orchards dip all young stocks in hot water (about 130 F.) or in tobacco water. If kerosene-emulsion is to be had, that will do. Dilute to the ordinary strength for summer spraying.

A liberal use of tobacco-dust about young trees, and old ones as well, will help to restrict the lice. Use wood-ashes whenever they may be obtained. The aerial lice on the limbs may be killed by a spray of kerosene-emulsion diluted ten times and forcibly applied. It has been found that trees grafted on Northern Spy stocks are very resistant to the woolly aphis. Abroad where this pest is

very aggressive, advantage is taken of this fact and almost complete immunity obtained.

AFFECTING THE TRUNK.

The Round-headed Apple-tree Borer. (*Saperda candida.*)

A number of borers work in the apple trees, but the two most important ones are the round-headed, and the flat-headed borers. The adult of the former is a very pretty beetle, slender in form, the female being about three-fourths of an inch in length, and the male a little smaller. The color is yellowish-brown, marked by two silvery stripes running the entire length. The antennae or feelers are long and slender.

The egg is said to be laid in an incision cut in the bark of the trunk. The larva bores in and works between the bark and the sapwood, making broad

Fig. 2.—Round headed Apple-tree Borer, from Riley, First Rep. State Entomologist of Mo.

flattened chambers often rounded like a coin, and filling these chambers with castings and frass Usually some of the castings protrude from the openings in the bark and thus betray the presence of the larva. Late in the season, the borer goes down somewhat deeper to pass the winter. The second season is said to be passed in the sap-wood. The tunnel of this species is round-oval in section, quite different from the broad-oval tunnels made by the flat-headed borer. Toward the end of the third season, the tunnel is extended into the hardwood and a channel provided for emergence the following spring, at which time the larva changes to a pupa, later changing to a winged beetle which gnaws through the bark and comes forth. Three years are said to be passed in the larval and pupal stages, the adult laying the eggs for another brood in June and early July. This beetle works also in pear, quince, mountain ash and several shade-trees.

REMEDIES.

In August and September, during the first year of its existence, the larva usually betrays its existence by pushing out excrement through the holes in the chambers low down in the trunk between the bark and sap-wood. The bark also is often discolored. An examination of the bark near the crown in September, and a trial with a stiff pin will show whether the chambers are there or not; if found, cut open and remove the larva. A wash of strong soft-soap and sal-soda is recommended by Mr. Saunders; reduce to consistency of paint and apply with a broom cut short so as to make a scrubbing brush. Apply about the first of June on a warm day. This will not be entirely satisfactory but the writer knows of nothing better.

The Flat-headed Apple-tree Borer. (*Chrysobothris femorata.*)

The commonest borer of the apple is the flat-headed borer. This pest probably take but one year to complete its development. The beetle is elongated, flattened, and in color greenish-brown. It averages little less than half an inch in length. The larva is flattened and broadened at the thorax just behind the head, making a wide oval tunnel necessary for the culture to progress. The work is done,

Fig. 3.—Flat headed Apple-tree Borer, from C. V. Riley, Insects of Mo., 1st Rep.

for the most part, between the bark and the sapwood, although the tunnel sometimes is cut deeper just before completion. The flat-headed borer does not confine its work to the crown of the trees, but may be found working in any part of the trunk and sometimes in the larger branches. The range of food plants is quite extended, covering besides the apple, white oak, mountain ash, box elder, peach, pear, basswood, soft maple, cherry and plum.

REMEDIES.

The same remedies that are recommended against the round-headed borer are useful against the flat-headed species.

AFFECTING THE BRANCHES.

The Buffalo Tree-hopper. (*Ceresa bubalis.*)

A small green insect, three-eighths of an inch in length, triangular in form, and shaped somewhat like a beechnut, but having the prothorax extending above the head in two horn-like growths. They sometimes weaken the twigs of apple by laying their eggs therein. The wounds so made are slow to heal, and on young trees may be the cause of injury through the breaking off of the twigs. No remedy is known except the cutting out of the eggs during the fall and winter.

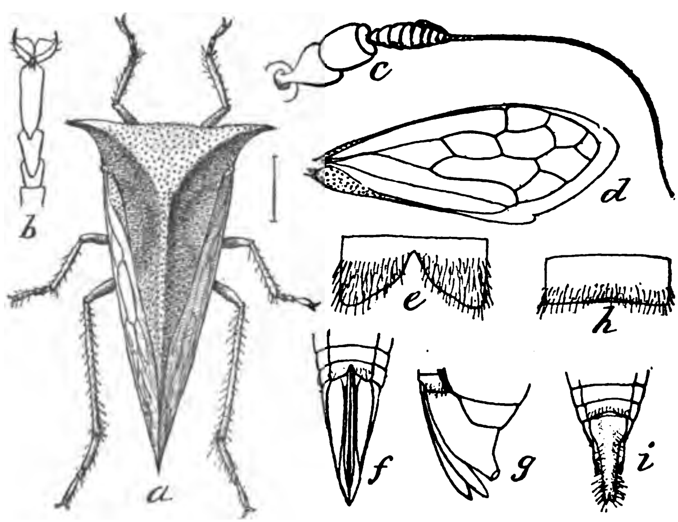

Fig. 4.—Buffalo Tree-hopper, after Howard "Insect Life."

Woolly louse of the apple (see insects affecting roots of the apple).
Apple twig-borer (see grape cane-borer).

AFFECTING THE BARK.

The Oyster-shell Bark-louse. (*Mytilaspis pomorum.*)

The most common scale-insect of the apple, without doubt, is the oyster-shell bark-louse. Although everywhere present, and sometimes quite conspicuous, it most often attacks trees that for some reason are unhealthy and therefore poorly fitted to support the extra drain put on them by the scale. A strong, healthy tree ordinarily can bear the presence of a few of these insects without much apparent injury, and they may be present for many years in small numbers without their presence being detected. When the tree becomes sickly the scales will multiply and carry it down very rapidly.

The scales of these insects are elongated, shaped something like oyster-shells, with the cast skins at the smaller ends. They are brown in color, the scales of the two sexes being similar in form.

REMEDIES.

When a tree shows many of these pests it usually indicates poor nutrition or some other unhealthy condition. Give the tree a tonic in the form of fertilizers and cultivation. Scrub with lye during the winter time. Ordinary lye from wood ashes will do as well as anything. Use an old broom with the brush cut short to make a good scrubbing brush, and if necessary, apply also one of the sprays recommended for the San Jose scale in the winter time. These strong mixtures will do injury if applied at any other time than when the trees are dormant.

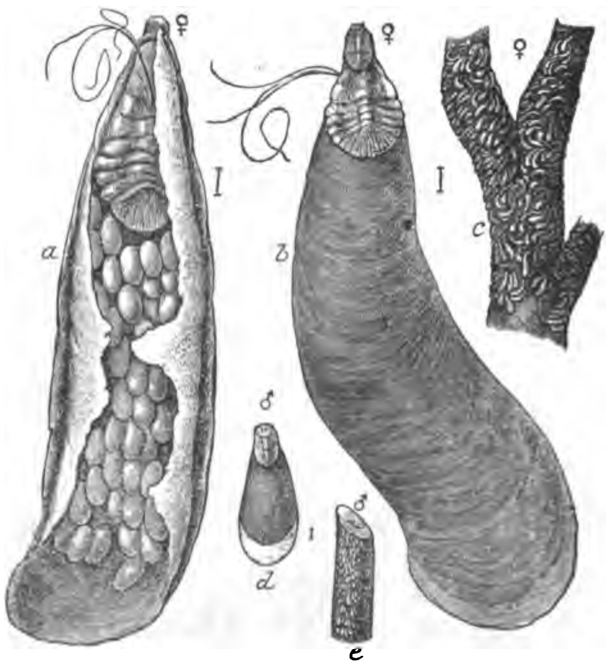

Fig. 5.—Oyster-shell Bark-louse, after Howard, U. S. Dept. of Agr. Div. of Entomology.

The Eccentric Scale. (*Aspidiotus ancylus.*)

Closely resembling the San Jose scale. but differing in some of the details, is the eccentric scale, sometimes called Putnams' scale in honor of its discoverer. The male scale in this case resembles that of the female in form and color, the cast skin being at one side instead of at the center as in the case of the San Jose species. The ring and nipple so conspicuous in the case of the San Jose scale, are usually obscure in the eccentric scale. This species propagates by means of eggs and rears but one brood a year It is not apt to multiply so as to

encrust the bark or to prove a serious drain on the tree. The scales often are grouped in small radiate clusters.

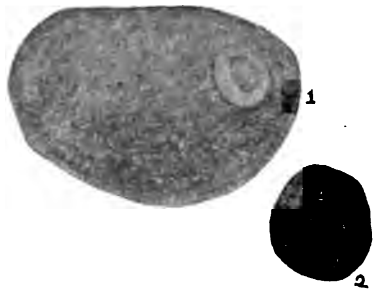

Fig. 6.—Eccentric Scale, from Author's Bul. 160. Mich. Ex. Sta.

REMEDIES.

In point of importance this scale must not be classed with the San Jose. It occurs on most if not all of our fruit trees and on many shade trees, but it may be present on such trees for years without being noticed. It succumbs to the same remedies as those used against the San Jose scale,—winter spraying with lime-salt and sulphur or with strong kerosene emulsion.

The Scurfy Bark-louse. (*Chionaspis fürfurus.*)

A scale insect that may be classed with the oyster-shell bark-louse so far as its economic importance is concerned, is the scurfy bark-louse of the pear and apple. The scale when newly made is pure white in color, with the cast skins

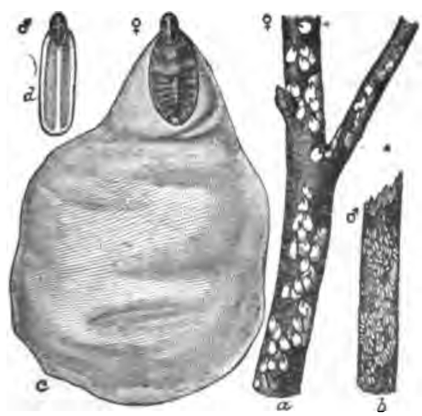

Fig. 7.—Scurfy Bark-louse, after Howard, U. S. Dept. of Agr. Div. of Entomology.

at one end, they being brown in color. The female scale is smooth while the male scale is narrow with three parallel longitudinal ridges running the entire length. This insect is apt to work on poorly fertilized and poorly cultivated trees.

REMEDIES.

The same remedies will apply as those recommended for the oyster-shell bark-louse.

European Fruit-scale (see Plum Insects).
English-walnut Scale (see Peach Insects).
San Jose Scale (see Peach Insects).
Fruit Bark-beetle (see Peach Insects).

AFFECTING THE FOLIAGE.

The Apple-tree Plant-lice. (*Aphis pomi, fitchii, and sorbi.*)*

Early in the spring, just as the buds commence to open, they are often attacked by small green plant-lice. At least three species of insects are concerned in this work, and of the three we have two and possibly three in Michigan. *Aphis pomi* (*mali*) the leaf-louse, comes on a little later in the season than the others, and stays on the foliage all summer, passing through several forms but using the apple and some other plants throughout the season for sustenance. It curls the leaves badly. *Aphis fitchii*, the most common species with us, appears on the buds as they open and stays through May, by which time winged forms will have appeared and migrated to other hosts, among them orchard grass. This insect disappears from the apple before summer. The third species, *sorbi*, resembles the second in that it migrates to other hosts after a comparatively short time on the apple. It also curls the leaves badly. All these lice secrete a sweetish sticky liquid called honey-dew and on this honey-dew a black fungus appears, which sometimes gives the trees a sooty appearance.

The eggs of these plant-lice are oval in form, black and polished. They are laid on the trunk, limbs and twigs of the tree, sometimes in very great numbers. The interesting stages through which these insects pass, have been described in other bulletins of this station.

REMEDIES.

Unfortunately no sprays have as yet been discovered which will successfully cope with these insects in the egg stage, but promptly applied sprays of kerosene-emulsion or tobacco-water will kill the young lice, especially if applied just after the eggs hatch. The practice of scrubbing the trunk and larger limbs with lye in the winter season, is of use in this connection though it is impracticable to reach the eggs on the twigs in this manner.

The Ring-legged Tree Bug. (*Brochymena annulata.*)

This insect is included in the present work not because it is likely ever to become serious, but because it is likely to appear from time to time, and occasionally to do some slight injury, if we may judge from the past history of this insect in Michigan. The figure will give an idea of the appearance of the creature. It may be killed by a spray of kerosene-emulsion.

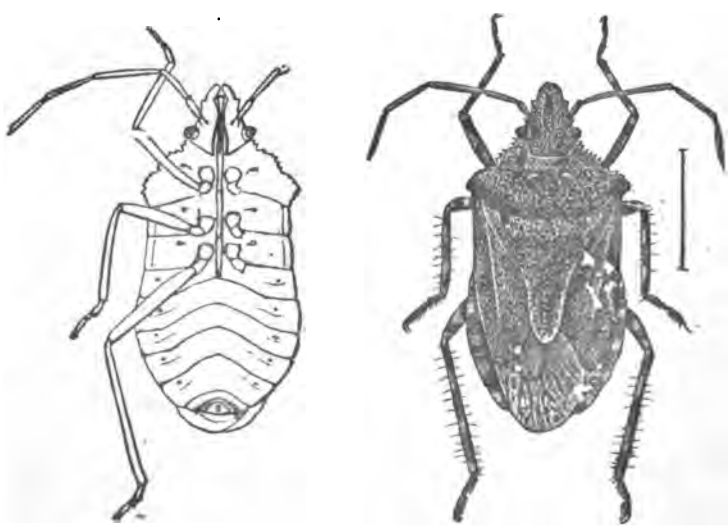

Fig. 8.—The ring-legged Tree-Bug, from Riley & Howard, Insect Life Div. of Entomology, U. S. Dept of Agr.

* The life histories of these lice were carefully worked out by Prof. Dwight M. Sanderson, then of the Delaware Exp. Sta

The Fall Web-worm. (*Hyphantria cunea.*)

During the latter part of the season one often sees the large, forbidding web of the fall web-worm, sometimes three feet in length and including leaves and branches. Inside the nest is the colony of caterpillars, each when full grown, more than an inch in length; and covered with long straight white hairs. The members of a colony come from a single cluster of eggs laid on a leaf. The caterpillars descend, when full-grown, to the ground, and either burrow slightly under the surface, or else hide in rubbish and spin cocoons in which to pupate. The adult is a moth usually pure white in color and measures about 1¼ inches from tip to tip of the wings. Some of the moths are more or less spotted with black. In the South this insect is said to be two-brooded. The work of this caterpillar can easily be distinguished from that of the tent-caterpillar by the hairy larvæ and the fact that the nest is extended as the colony grows larger. The larvæ of the tent-caterpillar being nearly smooth, and leaving the tent to forage, after they become partially grown.

REMEDIES.

Paris-green, applied early, usually keeps the tree clear, but after the nest is well under way, it must be removed by hand or burned out. A torch made of rags, wired to a long pole, and saturated with kerosene, will prove just the thing. It should be held some distance under the nest in order to cook the caterpillars and destroy the nest without injuring the branch. If placed too close to the nest, at first, the nest will burn like a flash and allow the larvæ to drop to the ground unhurt.

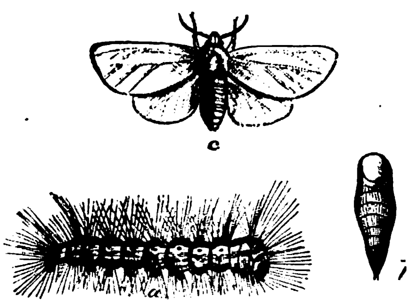

Fig. 9.—The Fall Web-worm, *Hyphantria cunea*, from Riley, Third Rep. State Entomologist of Mo.

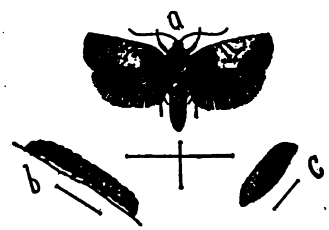

Fig. 10.—Bud Moth, from Davis.

The Bud-moth. (*Tmetocera ocellana.*)

Early in the spring, just as they commence to swell and open, the buds of apple and pear and sometimes those of plum, cherry, quince and peach trees, are occasionally attacked by small, almost naked caterpillars, about a fifth of an inch long, and dirty white in color, the head and thoracic shield being black or very dark brown. The caterpillars feed on the opening buds, later binding the young leaves and blossoms together with silken threads. Inside the nest thus formed, the larvæ feed and attain the length of nearly three-fourths of an inch, change to pupæ and finally to adult, winged moths, which usually emerge here during the last of June, or first part of July. The eggs are soon laid and the larvæ hatched, the young larvæ feeding on the under side of the leaves and skeletonizing them. When partially grown, they spin small nests or hibernaculi, in protected places, and remain until the following spring, when they attack the buds as described.

REMEDIES.

The best remedy is to spray with arsenicals just as the buds open. Cover the buds with poison, and the young larvæ will be killed early in their career. Sometimes more than one application is necessary, but be sure to hit each bud

with the spray. The presence or absence of the little nests later will indicate the success or failure of the application.

Canker-worms. (*Anisopteryx pometaria, and Paleacrita vernata.*)

Two of the most wide spread and destructive insects of the apple, are known as canker-worms. There are two species more or less common where apples

Fig. 11.—Banding a tree for Canker-worm. First operation.

are raised; the fall canker-worm and the spring canker-worm. The fall worm (Fig. 13), is perhaps the most common; it is a single-brooded insect, which lays its eggs either late in the autumn, or early in the spring. The egg hatches out a small loop-worm that grows to the length of nearly an inch. It varies greatly in color, but is usually gray or almost black, striped with yellowish or greenish. Being a measuring-worm, it has less than the ordinary number of legs, six true legs near the head and four false legs near the posterior extremity, with an extra rudimentary pair on the fifth abdominal segment. When full-grown, it descends to the ground and buries itself, sometimes several inches beneath the surface Here it forms a cell, by turning round and round, and changes to the pupal stage. Late in the fall, from the last of October to the time when the ground becomes frozen, the adult emerges and lays her eggs on the branches of the trees. Many of the moths do not emerge in the fall, but remain in the ground till spring. When adult, the two sexes differ greatly in appearance. The male is a pretty moth with ash-grey front wings marked by three transverse darker lines, and hind wings of silvery grey. The female, on the other hand, is not provided with wings, but has to crawl wherever she goes.

She is somewhat more robust than the male, and ash-grey in color, marked with black.

The life-history of the spring canker-worm conforms in most particulars to that of the one described, except that the adults do not come out until spring. The loopers or span-worms of this species lack the pair of rudimentary legs

Fig. 12.—Banding a tree for Canker-worm. Second operation.

on the fifth abdominal segment. The work of these insects usually is conspicuous, commencing in some restricted spot, and gradually spreading over an extended region. The branches of the infested tree are often covered with fine silken threads resembling spider webs. The leaves turn brownish in color, and often fall, making the trees look as if a hot wind had scorched them. When jarred, the worms will drop part way to the ground sustaining themselves in mid air by long threads.

REMEDIES.

Two methods of fighting this insect are known; first, banding with cotton-batting, to prevent the adult, wingless females from getting into the trees to lay their eggs, and second, spraying with the arsenites. Banding is done as follows,—a strip of cotton-batting about four inches wide and long enough to go around the trunk of the tree is placed as in (Fig. 11), a piece of ordinary white cord is then passed around the lower border of the band and tied tight, after which the top is turned down over the tied portion as shown in (Fig. 12). This will prove effective as long as the cotton remains fluffy, but it must be kept on from the first part of October until winter is well under way and then replaced during the first early thaws of spring and kept on until the foliage is well out.

As the worms feed on elm, cherry, basswood, plum, and several other trees, it will be necessary to band such trees also in order to keep the worms from breeding on them and reinfesting the fruit trees.

Spring Canker-worm.

Fall Canker-worm.

Fig. 13.—Canker Worms, from Riley. Eighth Rep. State Entomologist of Mo.

Spraying.—The most practical and efficient method, however, is spraying. Spray with paris-green when the worms first appear, and apply very carefully. The writer has had very good results with paris-green used at the rate of one pound to one hundred and seventy gallons of water. See directions for preparing insecticides. The worms usually appear just before blooming time, and may remain for a short time after the blossoms fall. In the case of the canker-worm, one is able to be prepared beforehand, for they spread with comparative slowness and they re-appear from year to year. Spray just as soon as they appear, of course abstaining during the time of bloom, and spray twice if necessary, paying particular attention to the nozzle used. Do not rely on throwing a spray to any distance. Reach the foliage with an extension and be sure that the spray is fine and fog-like. Be sure to stop just before the trees commence to drip. Very good work can be done with a fine Vermorel, cyclone, McGowan, or some other similar nozzle which will spread an even coat of poison without throwing large drops.

Apple-tree Tent-caterpillar. (*Clisiocampa americana.*)

Familiar to all are the large, sticky webs or nests to be found in apple trees early in the season, just after the foliage comes out. The nests contain colonies of caterpillars sometimes two inches long, dark brownish in color with a white line down the back and blue markings on each side. These large caterpillars go out and feed all over the trees, spinning fine lines wherever they go and for the first part of their existence at least, dutifully returning to the nest at night, remaining there in lowery or very cold weather. When full grown they spin oval cocoons of silk in partially concealed situations. The cocoons are notable for having a quantity of yellow powder mixed with the silk. The adults are moths, yellowish-brown in color, and spread something over an inch from tip to tip of the extended wings. They have two cream colored lines running obliquely across the front wings enclosing bands of lighter yellow. The eggs are laid in masses or clusters, all the eggs of one female being placed in a ring about a small twig, forming a characteristic, waxy thickening with rounded ends. Such an egg-cluster looks very much as if a small piece of chewing-gum had been wound about the twig and then smoothed and allowed to harden. Over

all is a varnish that remains intact until time for the eggs to hatch. There is but one brood each year.

REMEDIES.

The fact that the caterpillars pass the night in the nests, gives us an easy method of control. Early in the morning or in the evening, and sometimes in lowery cold weather, they can be burned out without very much trouble. Make a torch, by wiring a bunch of rags on the end of a long pole, soak in kerosene, and ignite. Such a torch will burn out a number of nests without renewing the oil. Hold the torch some distance beneath the nest so that the flames will scorch the larvæ and not simply destroy the nest, allowing the larvæ to drop to the ground uninjured.

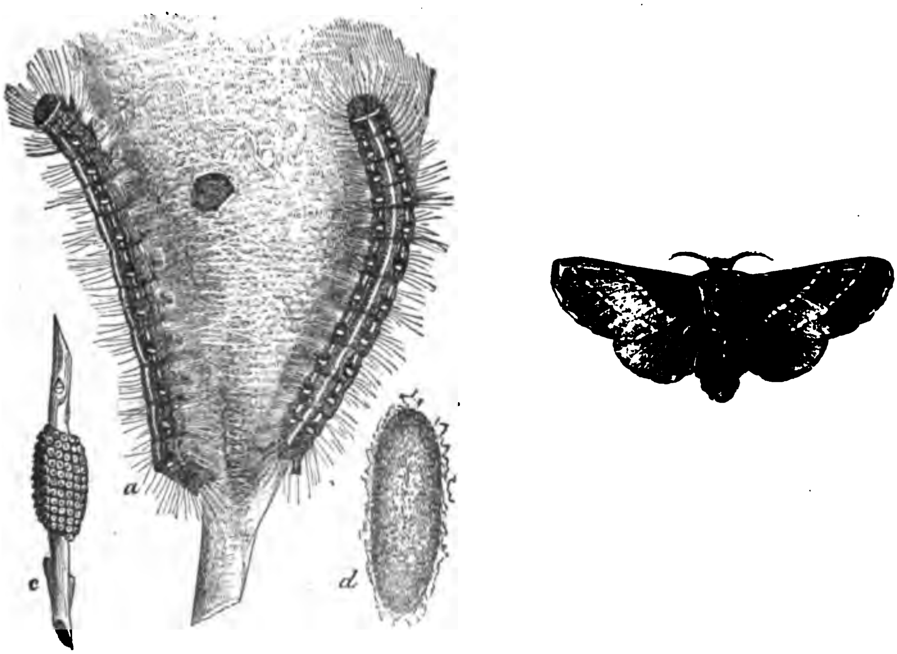

Fig. 14.—Apple-tree Tent Caterpillar, after Riley, Third Rep. State Entomologist of Mo.

Paris-green applied in the ordinary way, will kill the larvæ. A favorite method, used by boys, is to put a light squib of powder in a shot gun and to shoot at the nest at short range. The nest is usually completely demolished but many leaves are apt to go with it. Much may be done by picking off and destroying the egg-masses.

The Forest Tent-caterpillar or the Army-worm of the Forest. (*Clisiocampa disstria.*)

A near relative of the preceding species, is the forest tent-caterpillar, so named because of the close resemblance to the apple-tree species. The nest made by this creature, is rudimentary in the extreme, being difficult to find at all. The egg-masses differ from those of the orchard species, being more squarely cut off at the ends. The larvæ very closely resemble their tent-making relatives, but instead of a white line down the back these fellows are marked by a longitudinal row of lozenge-shaped spots with a continuous blue line on each side of the back, and transverse blue lines at each segment. The moths differ from the apple tree species in that the transverse, oblique band of the front wings is darker

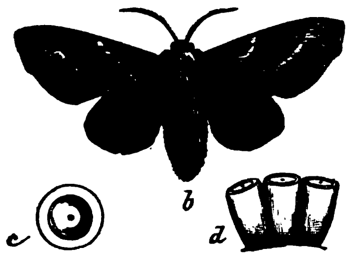

Fig. 16.—Forest Tent-caterpillar, after Riley, Third Rep. State Entomologist of Mo.

than the rest of the wing. The insect works on most of our shade trees, and on many trees of the forest, but it also loves the foliage of the apple. Owing to the fact that there is no nest to speak of the torch is of no use. Paris green applied in the ordinary manner, will kill them and the eggs may often be found and destroyed as in the case of the tent-caterpillar.

The Red-humped Apple-worm. (*Oedemasia concinna.*)

A caterpillar which works on apple trees and several other trees, and one which works in colonies, is the red-humped apple worm. It is of medium size, brownish, striped with black, and has a bright red hump on the hinder part of the thorax. The head is also bright red. The moth is brown in color and spreads a little more than an inch when the wings are extended. It is not a very common insect with us. When occasion demands, it may be controlled by cutting out the branch, or by paris-green.

The Yellow-necked Datana. (*Datana ministra.*)

Inquiries regarding this caterpillar, are always numerous. It occurs in colonies on the apple, and is conspicuous. The caterpillar is large and has the habit of holding itself by the false-legs, in the middle part of the body, and elevating both the head and tail in a threatening attitude whenever disturbed—standing to attention as it were. The caterpillar, when full grown, is nearly two inches long, striped longitudinally with black and yellow and is marked with a yellow band across the back of the neck. It is sparsely covered with fine, whitish hairs. The pupal stage is passed just beneath the surface of the ground and the adult is a fair sized brown moth havng transverse dark lines on the front wings. The eggs are laid on the foliage in large groups and the caterpillars feed in colonies.

REMEDIES.

Early in their life the caterpillars can be killed by hand at the expense of a branch or two but later when they spread, use paris-green in the ordinary way.

The White-marked Tussock-moth. (*Notolophus leucostigma.*)

Familiar to all is the tussock-moth. A conspicuous caterpillar about one and a half inches long, with yellow and black longitudinal stripes. The head, thoracic shield, and two spots on the backs of the sixth and seventh segments are bright red in color. Projecting forward from just behind the head are two tufts of long black hairs making a V-shaped fork half an inch long. Projecting backward from the tail is another single tuft. On the backs of each of the first four abdominal segments is a brush-like tuft or tussock of creamy hairs which gives the name to the creature.

They feed on apple, pear, plum, cherry and a large number of shade trees. The cocoon is usually poorly hidden, often being openly placed on bark or on adjacent fences. It is quite large and can easily be distinguished by the mass of eggs deposited upon it, in late summer.

The sexes differ greatly, the female being wingless and the male winged. The female is a swollen creature with weak powers of locomotion. She emerges from the cocoon, meets the male, deposits a batch of eggs in a white, frothy mass on the side of the cocoon and dies. The winter is passed in the egg stage. We probably have but one brood in Michigan, although in the South there are said to be two broods. The damage inflicted by these tussock-moths often is severe both to fruit trees and to shade trees.

REMEDIES.

Paris-green applied in the ordinary way, will kill the larvæ or caterpillars. Hand picking or burning the cocoons is really practicable in this case, as the cocoons are fairly conspicuous owing to the frothy mass of eggs thereon. Cotton bands such as are used for the canker-worm, will keep the caterpillars out of trees previously cleared by hand picking.

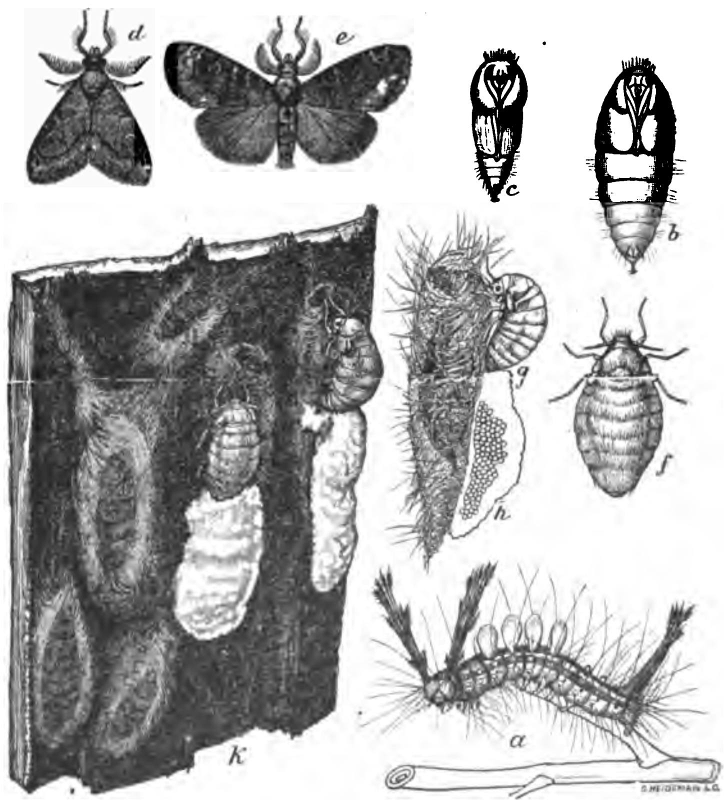

Fig. 17.—Tussock-moth, after Howard, Div. of Entomology, Dept. of Agriculture.

The Palmer Worm. (*Ysolopus pometellus.*)

An insect little known among the fruit growers, is the palmer worm. Appearing as it does, at long intervals of time, one hardly gets acquainted with it before it is gone, leaving no word as to when it may be expected again. The explanation for its sudden multiplication into great armies, from comparative obscurity and the subsequent relapse into rarity is hard to make. Suffice it to say that at intervals of perhaps fifty years, more or less, the pests appear and work great havoc

in apple orchards, on oak and on many other trees and shrubs.

The larva is described by Lowe as being about half an inch long, slender and tapering; in color, varying from flesh color to yellow, tinted with green. The head and shield vary from light yellow to dark brown. Three dark lines extend the length of the back, the middle one being sometimes divided longitudinally into two lines. The body is sparsely covered with fine hairs arising from small black points. These larvæ appear in June, skeletonize the leaves and eat into the fruit. They usually either bridge across a crease in the foliage with fine silken threads, or else turn back an edge of the leaf and fasten it, thus making a nest.

Fig. 18.—Palmer worm, after Slingerland.

The naked pupæ are placed in all sorts of places, in the nest, under bark, or in grass at the foot of a tree.

The adult is a very small moth spreading about half an inch from tip to tip of the extended wings. The color of the front wings is ash-grey, marked with several dark dots, the hind wings being dusky with a steel blue reflection. They come out in late June or early July.

REMEDIES.

Trees sprayed with paris-green, as is done for the codling-moth, are said to be comparatively free from these pests. As one never knows when they may appear this is one more reason for spraying for the codling-moth.

The Resplendent Shield-bearer. (*Aspidisca splendoriferella.*)

During late fall and early winter, one often sees the small cases made by this insect, attached to the bark of apple trees. They are more or less oval, pointed at both ends and less than one-eighth of an inch long. The life history

of this case bearer is carefully described by Professor Comstock, in his Annual Report of the Division of Entomology, in the Department of Agriculture for 1879. The young larva just from the egg acts as a miner, working between the upper and lower surfaces of the leaves. When full-grown, it spins inside of the mine, a lining just the size that the case is to be, and after the upper and lower epidermises are bound down by this lining, the larva cuts out the case from the outside, making a small pocket just large enough for the larva to enclose its body. From the mouth of the pocket, the head and thorax project, allowing the larva to walk about while the soft body is enclosed in the pocket

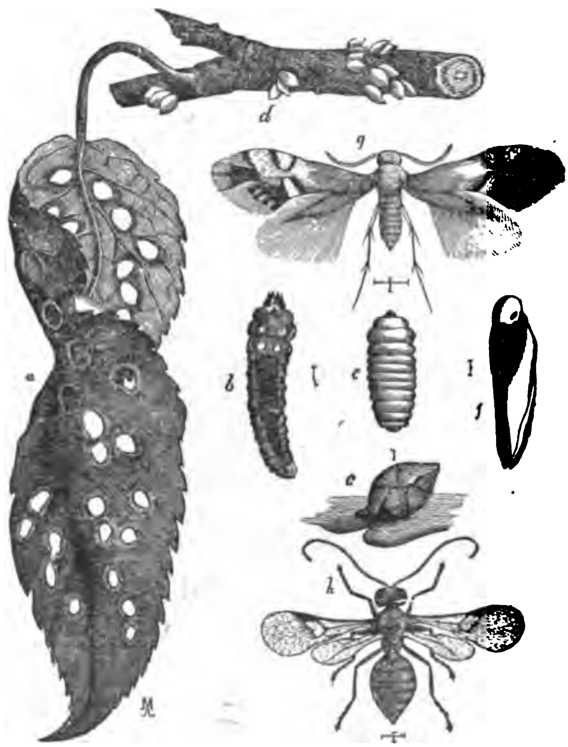

Fig. 19.—Resplendent Shield-bearer, after Comstock, Rep. of Entomologist for 1879, Div. of Entomology, U. S. Dept. of Agr.

or case made from the leaf skins. After the larva has attained its full size, the case is then fastened to bark or to something permanent. The larva draws its body entirely within the case and changes to a pupa, from which the adult moth emerges in May to lay eggs for the next brood. The moth that is the cause of all this trouble, spreads about three-sixteenths of an inch from tip to tip of its extended wings. It is brilliantly colored in metallic hues and well deserves the name of "resplendent." Besides apple it works on pear, thorn-apple and wild cherry.

REMEDIES.

Professor Comstock recommends a winter wash of lime and sulphur, using six pounds of sulphur to half a bushel of lime and applying as a white-wash whenever the insects become numerous enough to threaten the safety of trees. In the South these insects are said to rear two broods a year.

The Pistol Case-bearer. (*Coleophora malivorella.*)

An insect, closely related to the cigar case-bearer, is the pistol case-bearer. It is found on apple, plum and cherry, the minute pistol-shaped cases being built up out of particles of leaf, with silk, according to Professor Slingerland.*
The life history differs somewhat from that of the cigar case-bearer, but not so materially as to affect the treatment. The remedy is to spray twice between the time of their attack and the time of bloom, using paris-green in the usual way.

The Cigar Case-bearer. (*Coleophora fletcherella.*)

This very interesting little creature is occasionally so numerous as to cause injury to apple and pear. The larva makes a case in a manner similar to the resplendent shield-bearer. This little case resembles a minute cigar about one-fourth of an inch long. It is very carefully described by Professor Slingerland in Bulletin No. 93 of the Cornell University Experiment Station. The larva is said to make two cases during its lifetime, one in the fall, curved and very small, and one in the spring in which the pupal stage is passed. It attacks the buds as they swell, and later feeds on fruit and foliage reaching out from the case and mining under the skin of the leaf. The adult is said to be steel grey in color and spreads less than half an inch from tip to tip of its wings. It may

Fig. 20.—Cigar Case-bearer, after Slingerland.

be controlled by early sprays of paris-green, applied when the buds open, and also at the time when the trees are sprayed for the codling-moth. Usually it will be found expedient to add the poison when spraying with Bordeaux for the scab, thus reducing the expense.

Apple Leaf-miner. (*Tischeria malifoliella.*)

As the name implies, this is an insect which tunnels in the foliage of the apple, burrowing between the upper and lower surfaces of the leaf, and feeding on the soft tissue there found. The mines of these little creatures are quite variable in form yet all conform to a general type. Usually at the starting point, there is a slender part which broadens as it progresses from the point where the egg was laid, and which often is marked with transverse bands of light and dark. (See Fig. 21.) After the mine is partly made the last part may be blotch-shaped or irregular in outline, and this blotch may even extend under the original trumpet-shaped portion. The insect which does all this mining is a small larva without feet, and pale green in color, except for the head

* Bul. 124, Cornell University Experiment Station.

and part of the thorax, which are brown. The pupal stage is passed in the mines of the leaves, necessarily on the ground in the winter time. The adult which comes from the pupa is a dainty, purplish moth with occasional yellow scales. It is so small that it measures only about a quarter of an inch from tip to tip of the extended wings. The effect produced by many of these mines is merely equivalent to removing some of the foliage, but unfortunately this insect sometimes takes to blackberry foliage, there doing severe injury. See blackberry insects.

Fig. 21.—Apple Leaf-miner, work on apple leaf. Author's illustration.

REMEDIES.

The fact that the pupal stage is passed in the mines, plainly indicates that when the insect is present, the leaves should be gathered and destroyed in the fall. No spray can be used with benefit as the young are protected by the skin of the leaf under which they burrow.

The Apple Leaf-tyer. (*Teras minuta cinderella.*)

A small larva that folds together the upper surfaces of apple and pear leaves, folding them along the midrib and fastening with silk. Inside this folded leaf the larva dwells. It may be combated by early spraying with paris-green.

The Banded Purple Butterfly. (*Basilarchia arthemis.*)

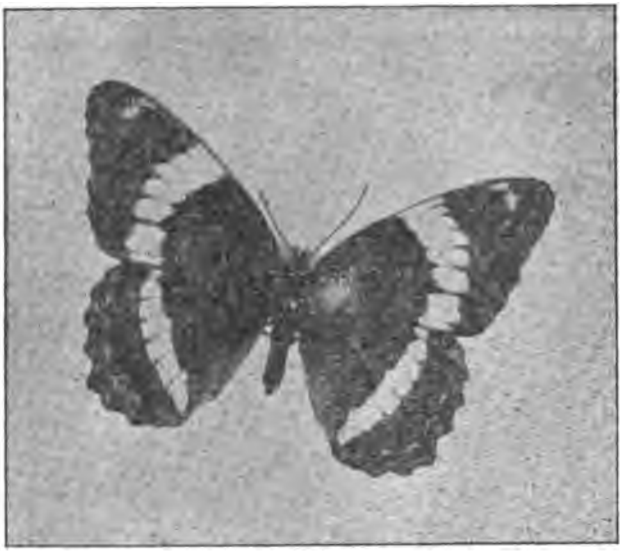

Fig. 22.—Banded Purple Butterfly, nat. size. Author's illustration.

Fig. 23.—Folded leaves or hibernaculi in which the small larvæ of the Banded Purple Butterfly pass the winter, enlarged. Author's illustration.

In the northern part of the state it sometimes happens that injury is done to young apple trees by the larvæ of the banded-purple butterfly. In this region comparatively few apple trees exist, and when a young orchard is set out the caterpillars shows a preference for apple foliage over that of the native food

trees. When the trees become larger the damage becomes insignificant.

The life history of this insect differs slightly from that of most of our butterflies. Instead of passing the winter as an adult or in the pupal condition as most butterflies do, this insect, in common with others of its genus, builds a retreat or hibernaculum out of the base of the leaf, binding it up with silk, and passes the winter therein while still very small. Fig. 23 shows several such hibernaculi considerably enlarged. In the spring the larva attacks the buds almost before they open, and later feeds on the foliage. In a young tree a few such larvæ feeding on the new leaves can do a great deal of injury.

REMEDIES.

Paris-green applied in the ordinary way, will kill the larvæ in the spring time when they commence operations. Hand picking was found to be economical and effective in the case of the station orchard in Alger county. There is danger only when the trees are small and at such times the trouble of hand picking is reduced to a minimum.

The Psocids. (*Psocus Spp.*)

These are small insects appearing like over-grown plant-lice, from which they may be distinguished by the mouth parts which are formed for gnawing, and by the wings, which have many veins forming a coarse network, instead of

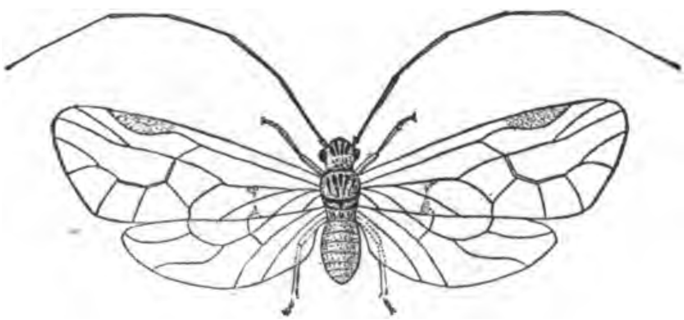

Fig. 24.—*Psocus lineatus*, after J. B. Smith, "Economic Entomology."

having few veins in the wings and sucking mouth-parts as in the case of the plant-lice. These insects sometimes collect in large patches on the trunks of trees, usually before a storm. They feed on lichens, bark, etc., doing no harm so far as is known. They are, however, often mistaken for injurious insects and for this reason are included in this bulletin.

AFFECTING THE FRUIT.

The Codling Moth. (*Carpocapsa pomonella.*)

This native of Europe is, without doubt, the most serious of the insect enemies of the apple with which we have to deal. The life history is as follows: The winter is passed in the larval stage, spun up in the cocoon ready to change to the pupal or true cocoon condition early in the spring. The cocoon may be concealed under rubbish or under a loose piece of bark. In April the change to the pupal condition is made, and in late May or early June the adult moth emerges. By the middle of June most of the first batch of eggs are hatched out, and the young have entered the apple, about 80 per cent of them, at the blow end or calyx. During the first part of July they spin up, making cocoons under loose pieces of bark, or in rubbish, and by the end of July, most of the adults of the second brood are out. The third brood may sometimes occur in Michigan. When it develops it is due in the latter part of September. It is, however, of small consequence because it is likely to be a small brood. Much

latitude must be allowed in considering these dates as the broods string out and overlap. The dates given seem to be the times for the greatest number of insects during the season of 1903.

The injury by the first brood is slight compared with that inflicted by the second brood, because the apples injured early in the season fall to the ground, long before they ripen, while the apples injured by the second brood of insects, either rot on the trees or just after picking, sometimes doing so after packing when they are apt to spoil many sound fruits at the same time. The larvæ of the second brood usually enter the fruit on the side or where two apples or an apple and a leaf touch, about 80 per cent according to our counts, the remaining 20 per cent going in at the calyx. Now the second broods do the most damage, but the first brood is by far the easier to destroy, and as the first brood is parent to the second, no effort should be spared to kill as many of them as possible. The question of spraying to catch these two broods will be taken up under remedies.

As has been stated the insects pass the winter as larvæ enclosed in cocoons, for the most part under thin pieces of bark scale. The great majority of larvæ

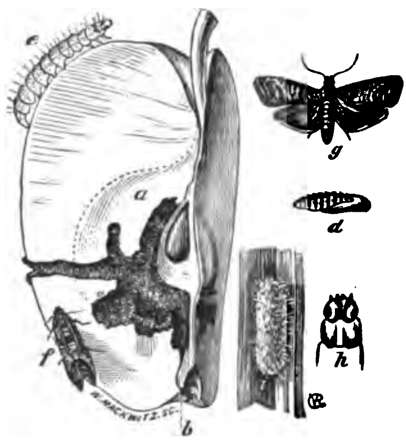

Fig. 25.—Codling-moth, after Riley, American Entomologist.

in such situations are eaten by woodpeckers, nuthatches, etc., during the winter time, but a few especially well hidden, and those below the snow line, escape. If the loose bark scales below this line be brushed or scraped off it will drive the insects up into parts accessible to the birds. Great numbers winter in old apple barrels, beneath the hoops, and in the crease near the bottom, also in cellars where apples are stored, in cold storage houses, etc. The moths come forth from such places and invade the orchards.

The adult, winged moth is about the color of the bark of the tree, brownish grey with transverse wavy lines on the front wings. At the hind ends of the wings are areas of darker color with bronzy patches. The moth is about three-eighths of an inch long and when sitting with closed wings, resembles a small patch of lichen or rough bark; so close is the resemblance that it is very difficult to detect them. The cocoon when made under a loose scale of bark, is about one-half inch long, oval in form and flattened so as just to occupy the space allowed. Often a tube extends from one end toward the outer side, the larvæ commencing to spin where the crack is too large and building a tube as it crowds in toward the narrow part. In the winter cocoons, there is usually a good deal of chewed up fibre in the sides of the cocoon, but silk alone inside, and where it comes in contact with the outer and inner bark.

REMEDIES.

The time honored practice of spraying with paris-green just as the blossoms fall, is the best method known, if the work is to be expended in one effort, but several sprays are better than one. Use one pound of paris-green or its equiva-

lent in strength of some arsenical, and one pound of quick-lime to one hundred and seventy-five gallons of water. Use a fine nozzle and apply after the petals fall but before the young fruit turns down. Put a drop of poison in each calyx cup so that when the larva comes a few weeks or days later, and attempts an entrance, it will get a little of the preparation. If two sprays are to be applied, put on the second about the first of August so as to catch the larvæ of the second brood as they try to go in through the side of the apple. These two sprays are necessary to obtain good fruit as a general thing, if more than two sprays are to be applied, put them on two weeks or ten days before and after the August spray.

Fumigation of cellars where apples are stored and destruction by fire of old apple packages about the first of May, will prove very useful. Use three pounds of brimstone to one thousand cubic feet of air space in the cellar or storage room. Bands of burlap placed about the trunks of the trees will furnish convenient places for the larvæ to pupate. If they are to be forced under the bands, however, the trees will have to be scraped. Ordinarily it will be expedient to apply the earlier sprays with bordeaux in order to prevent the scab. The August spray, however, probably will be best with lime alone, as bordeaux is not so effective late in the season. Whenever spraying for scab, it will pay to put in a little paris-green, on general principles.

The Apple Maggot. (*Rhagoletis pomonella.*)

Sweet apples and also semi-acid ones, are often attacked by a "worm" which tunnels all through the flesh indiscriminately. An examination of the culprit shows him to be footless and without a distinct head, the mouth parts of dark horny material, however, showing through the skin. This is the apple-maggot, somewhat smaller than the house-fly, and with wings marked by dark bands. The eggs are laid in pockets cut under the skin of the fruit, and the maggots which hatch from them, tunnel indiscriminately through the flesh, not confining their work to the vicinity of the core as does the codling moth. After the fruit falls to the ground, the maggot passes out into the soil and changes to a puparium, which stage corresponds to the cocoon stage of many familiar insects. In the spring, the fly comes out ready to lay another batch of eggs in the young apples.

REMEDIES.

The habit of laying eggs beneath the surface of the fruit precludes the use of sprays. No spray will reach either the egg or the maggots. The only time when they can be successfully combated, is after the fruit falls, and before the maggots go into the soil. At this time the fruit may be destroyed in several ways; the orchard may be kept clean by hogs or sheep, or the apples may be gathered every day and made into cider, or else fed to stock. In the latter case, they should be fed on a tight board floor so that the maggots can not come out of the apple and burrow into the soil. If no use for the fallen fruit presents itself, then gather it and bury in trenches or pits. Well cultivated orchards are less apt to be badly infested than are those in sod, as the pupæ in the soil are disturbed by the cultivation and exposed to their natural enemies. Fowls, birds, shrews, etc., pick up many of the pupæ thus exposed.

Green Fruit-worms. (*Xylina Spp.*)

From time to time, green "worms," about the size of cut-worms, are to be seen working on fruits. The writer has usually found them on apples and once on strawberry. They are apple-green or light-green in color and have three light-yellowish stripes running the entire length, one line on the back and one on each side. Sometimes there are additional markings which are quite variable. They eat holes in the young fruit and foliage. They are said to work on a number of trees and shrubs, including most of the fruits grown in Michigan, feeding during the day and probably also during the night, and dropping to the ground when disturbed. The pupal stage is passed in earthen cells in the ground. Professor Slingerland, who discusses these creatures at length says* that the insects are very difficult to kill with the ordinary late sprays, but

*Bul. No. 123, Cornell University Experiment Station.

Fig. 26.—Green Fruit-worm, after Slingerland.

that trees sprayed before they blossom, with the arsenites and bordeaux are apt to be pretty free from them. As the insects are periodic in their invasions, often disappearing for a number of years together, it is not possible to fortell just when such a spray will be necessary. Those who apply bordeaux before the buds open, as a regular practice, may find it a paying investment to add a little poison for this insect, the bud-moth, and several other pests. Professor Slingerland also recommends jarring in the same manner as for curculio. The bulletin cited gives much detailed information on the subject.

Climbing Cut-worms (see Peach Insects).

INSECTS AFFECTING THE RASPBERRY AND BLACKBERRY.

AFFECTING THE ROOTS.

Raspberry and Blackberry Crown-borer. (*Bembecia marginata.*)

A borer which the writer has seen in the western part of Michigan is the blackberry crown borer. The adult of this insect is a good sized clear-winged moth, black and yellow in color, with orange front wings. It resembles a very large yellow-jacket in a general way but really is a moth. The larva is provided with feet as in the case of the imported currant-borer, and is to be found about the level of the ground either in the canes above or about the roots, sometimes completely girdling the root beneath the surface of the soil. The young are said sometimes to go up into the new growth.

REMEDIES.

No better measure is known than that of cutting out the larvæ and digging up and burning the dead bushes. Fortunately this insect is not so common as the cane-borers.

AFFECTING THE CANES.

The Raspberry and Blackberry Cane-borer. (*Oberia bimaculata.*)

The adult of the raspberry cane-borer is a slender, cylindrical beetle with long feelers or antennæ. The wing-covers and head are black and the prothorax yellow. The eggs are laid in June, in a very characteristic manner,—the new growth of a cane is partially girdled in two places about an inch apart, and

an egg is deposited in a puncture about midway between the two girdlings. In a short time, the cane droops and dies above the upper girdle, which drops off, and leaves the segment containing the egg to wilt, furnishing the conditions necessary for the development of the egg and the proper food for the new-born larva. Later the larva bores down the cane, feeding on the pith and passing the winter in the tunnel, afterwards changing to a pupa, and in time, to the adult insect, which cuts its way out the following June. The footless larva is yellowish in color. The head is brown.

REMEDIES.

The characteristic method of topping or cutting off the tops of the canes, makes it easy to recognize the work of this pest. If the wilted tops are seen in June, cut off at the lower girdling, if later, then cut off below the bottom of the burrow, and burn.

The Red-necked Agrilus, or Maker of the Gouty Gall. (*Agrilus ruficollis.*)

About pruning time, we often see swollen places in blackberry and raspberry canes, the swollen parts usually showing cracks on the outside. On paring off

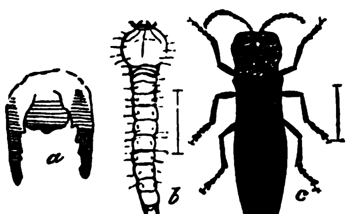

Fig. 27—Red-necked *Agrilus*, after Riley, "American Entomologist."

Fig. 28.—Gouty Gall, after Riley, American Entomologist.

the skin, we find a spiral tunnel, just beneath the bark. Such swollen galls or gouty galls, are produced by the larvæ of a very pretty little beetle about five-sixteenths of an inch long, and slender in proportion. It is bronze in color, with the prothorax reddish bronze. The larva is white, flattened, and with a widened thorax. The tail is forked. This pest works in both wild and cultivated plants, seeming to prefer the wild ones.

REMEDIES.

Cut out and burn the affected galls when pruning. See that no affected wild plants are near to restock the field after it is cleared of galls. Galled canes are useless, so far as good fruit is concerned, therefore no hesitation should be felt in cutting them out.

The Tree-crickets. (*Oecanthus* Spp.)

Many times one finds long rows of punctures on the sides of raspberry and blackberry canes, and also on the new growth of peach trees. When such a twig is split along the row of punctures, each hole is found to contain an egg, the egg of a tree-cricket. The rows vary in length from one to several inches, and sooner or later usually cause the twig to split open, weakening the twig

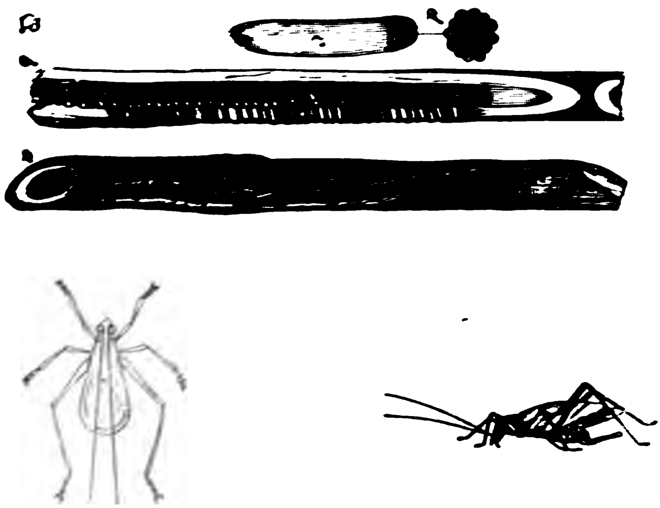

Fig. 29.—Tree-crickets and their eggs, after Riley, Fifth Rep. State Entomologist of Mo.

if not killing it outright. The cricket that causes all this trouble is a delicate little creature, light colored, sometimes with dark markings, and provided with good sized wings. It is perfectly harmless except for the habit of placing its eggs in twigs in the autumn. In fact it is said to feed largely on plant-lice and therefore to be our friend.

REMEDIES.

The only practical method of combating these insects is by cutting out the affected canes and twigs and destroying them by fire. If not at all numerous, they may safely be ignored.

AFFECTING THE FOLIAGE.

Raspberry Saw-fly. (*Selandria rubi.*)

The raspberry saw-fly is an old offender from which we may expect to hear periodically. The false-caterpillar, that does the damage, is a delicate green "worm" about three-fourths of an inch long and densely covered with green spines. They sometimes occur in great numbers and eat numerous holes in the foliage especially of the red raspberry. The life history of the insect is as follows: The eggs are laid under the skin of the leaf, not far from one of the large ribs during the latter half of May, the larvæ, at first white, and afterward the color of the leaf, are covered with transverse rows of divided spines. When full-grown, or in about a month from the time of the laying of the eggs, they descend and burrow into the ground to spin firm cocoons composed of silk and bits of earth. Here they change to pupæ and emerge the following spring as adult saw-flies.

REMEDIES.

The larvæ of this insect readily succumb to almost any of the poisons, but unfortunately they appear when the fruit is set. Hellebore may be used if the fruit is not too far advanced, kerosene-emulsion has been used successfully, and there is reason to believe that an ounce of Persian insect-powder added to each gallon of emulsion before diluting, will greatly improve its efficacy. Strong soft-soap has also been successfully used, but it must be borne in mind that each "worm" must be hit to be killed, and that new eggs are constantly hatching out larvæ, often demanding a repetition of the spray.

Apple Leaf-miner. (*Tischeria malifoliella.*)

The life history and method of living of this little moth were discussed under apple insects. Unfortunately it works also in blackberry and sometimes becomes so numerous as to need attention. The mines in blackberry are large and blotch-shaped. There are two broods, one going into the pupal stage in July, and the other in September and October. The late brood passes the winter in the pupal stage in the mines in the fallen leaves, (See Apple Leaf-miner under Apple).

REMEDIES.

As the larvæ work entirely under the surface of the skin no spray proves effective against these pests. Much good can be done, however, by raking up the foliage and burning, whenever these conspicuous miners are seen to be present. In small patches it sometimes proves worth while to pick off the affected leaves and destroy them.

(*Anomala undulata.*)

A medium sized shiny leaf chafer, having the form of a June-bug, but very much smaller, dirty yellow in color, marked with black, and about one-third of an inch long. The adult feeds on blackberry, plum, pear, apple, grape, wheat, peas and other plants, eating holes in the foliage. When numerous they have been known to strip the plants. They are occasionally visitors in Michigan, that is, they occasionally multiply to sufficient numbers to become pests. The immature stages are passed in the ground. The grub resembles an immature white grub.

REMEDIES.

These pests should respond to a spray of paris-green applied in the ordinary manner when the fruit is not set. When fruit is on the plants, use hellebore or else beat the beetles into dozers as in the case of the rose-chafer.

INSECTS AFFECTING THE CHERRY.

INSECTS AFFECTING THE TRUNK.

The Divaricate Buprestis. (*Dicerca divaricata.*)

This is a medium sized beetle with very hard, strong wing-covers and a flattened body. The surface is bronzy, and furrowed, the spaces between furrows being highly polished. This insect bores into living wood much as does the flat-headed apple-tree borer. It works in cherry and most of our stone fruits beside a number of forest trees. The remedies are the same as those for the flat-headed borer of the apple.

INSECTS AFFECTING THE FOLIAGE.

The Cherry-tree Plant-louse. (*Myzus cerasi.*)

A large, black, polished plant-louse that works on the young shoots and tender foliage of the cherry, often appearing in very great numbers. They multiply rapidly, sometimes covering the twigs and young fruit, and secreting a sticky sweetish liquid called honey-dew. This attracts ants, yellow-jackets, flies, etc.

Late in the season they often become numerous before laying the eggs for the spring brood.

REMEDIES.

Kerosene-emulsion or any of the contact insecticides, applied in the ordinary way, except that it should be a little stronger than when used for green lice. It must be borne in mind that each louse must be hit in order to be killed.

The Cherry Leaf-beetle. (*Galerucella cavicollis.*)

A small, dark-red beetle less than one-fourth of an inch in length, oval in form, and with the antennæ and parts of the legs black. This small beetle feeds on cherry. The writer has seen them in great numbers on pin cherry (a wild cherry) at AuTrain Falls in late August. The beetles have welcomed with enthusiasm the introduction of the cultivated cherry in their haunts, readily accommodating their taste to the new food. They feed on the leaves, and often come in large numbers, appearing in June and again in September. In the Northern Peninsula they do a great deal of damage to young trees, coming out of the ground from a depth of several inches, and attacking the young foliage about the first of June. The larvæ also works on the foliage, following the adults.

REMEDIES.

When on old trees not in bloom, these beetles may be killed with paris-green and lime, one pound of the poison to one hundred and seventy-five gallons of water, but on very young trees the case is more difficult. Mr. Geismar, the superintendent of the Upper Peninsula Experiment Station, points out the fact that the beetles either hibernate or pupate under the surface of the soil, often

Fig. 30.—Cherry Leaf-beetle. Author's illustration.

Fig. 31.—Pear Slug, from Saunders, Insects Injurious to Fruits.

at a depth of several inches, and usually within a few inches of the base of the tree. He finds also that they are almost sure to climb the tree instead of flying, being somewhat sluggish on first coming to the surface. This suggests the use of narrow bands of sticky fly-paper or loose cotton at such times in the case of young trees. The beetles eat very voraciously and a few dozen can work havoc in a young tree, especially if it is in bloom and one does not wish to spray.

Bud Moth (see Insects affecting the apple).
Cherry Slug or Pear Slug (see Insects affecting the pear).
Apple-tree Tent-caterpillar (see Insects affecting the apple).
White-marked Tussock-moth (see Insects affecting the apple).
Canker-worm (see Insects affecting the apple).
Fall Web-worm (see Insects affecting the apple).

INSECTS AFFECTING THE BARK.

Fruit Bark-beetle (see Insects affecting the peach).
San Jose Scale (see Insects affecting the peach).
European Fruit-scale (see Insects affecting the plum).
Eccentric Scale (see Insects affecting the apple).
English-walnut Scale (see Insects affecting the peach).

INSECTS AFFECTING THE FRUIT.

The Cherry Fruit Fly. (*Rhagoletis cingulata.*)

Without doubt the great majority of the "worms" of "wormy cherries" in our state, are the grubs of the plum curculio. There is, however, another insect whose larva develops in the cherry. This second cherry worm was carefully studied by Professor M. V. Slingerland, and his account published in Bul. No. 172 of the Cornell University Experiment Station. The fly is described as being about three-sixteenth of an inch long, somewhat resembling a house-fly, except as to size and the fact that the wings are marked with four transverse bands of a blackish color. The larva is more slender than the grub of the curculio, resembling more closely the larva of the apple maggot. In the case of the curculio, one finds infested cherries bearing the characteristic crescent-shaped scar, cut in when the egg was laid. In the case of the cherry fruit-fly there may be no indication of the presence of the maggot from the outside up to the time when the maggot is full grown, at which time, the part of the fruit most tun-

Fig. 32.—Cherry Fruit-fly, after Slingerland.

neled under, sinks in or rots, thus indicating the presence of the pest. The pupal stage is passed in the soil. In the spring the adult fly emerges and probably lays her eggs beneath the skin of the young fruit where no spray will reach it.

REMEDIES.

No practical remedies seem to have been as yet discovered other than picking the fruit as soon as it shows the presence of the insect and deep cultivation early in the season, to bury or crush the pupæ.

Plum Curculio (see Insects affecting the plum).

INSECTS AFFECTING THE CURRANT.

INSECTS BORING IN THE WOOD.

The Imported Currant-borer. (*Aegeria tipuliformis.*)

The currant and gooseberry are often attacked by a borer that works in the center of the branch, tunneling down quite a distance and interfering seriously with the development both of the foliage and of the fruit, and eventually bringing about the death of such tunneled wood. Stems containing borers show the presence of the invader by wilted and stunted foliage early in the season. The larvæ after feeding on the pith and central part of the stem until autumn, pass the winter in the tunnel. In the spring when the plant starts to grow the larvæ are awakened to new activity and quickly complete their growth. Before changing to pupæ they eat their way almost through to the outside, plug up the hole loosely and retire. The pupal stage is entered upon and in June the adult moths come out to the open air. In this stage, the insect is very beautiful, being a little less than half an inch long, slender, and brilliant black and yellow in color. The wings are only partially covered with scales, the uncovered part being transparent. For this and other reasons they are placed among the group of moths known as clear-wings. They so closely resemble wasps that one hesitates to handle them without careful examination. The figure shows the adult larva and pupa. It will be noticed that the larva possesses feet like those of most moths.

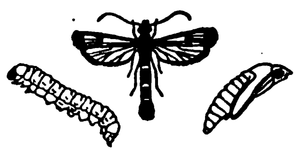

Fig. 33.—Imported Currant-borer.

REMEDIES.

When the foliage commences to expand, the mutilated stems can be distinguished by the sickly appearance of the leaves. Cut out all tunneled stems below the lowest part of the tunnel, and burn them. If this practice be constantly followed up, the bushes can be kept fairly free from this borer.

The Native Currant Borer. (*Psenocerus supernotatus.*)

Curiously enough, we have two borers working in the currant, one belonging to the clear-winged moths, imported from Europe, and the other a native insect belonging to the beetles. Fig. 34 shows one of the adult beetles. It is from

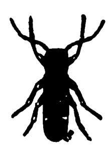

Fig. 34.—Native Currant-borer.

three-sixteenths to one-fourth of an inch long, brown in color, with the posterior half of the wing-covers darker than the rest of the body, and with two whitish spots on each wing-cover. The larvæ or grubs of this beetle are footless, and work very much as do the imported borers, except that usually several work together instead of singly as in the case of the other. The same remedies apply as in the case of the imported species.

INSECTS AFFECTING THE BARK.

European Fruit-scale (see Insects affecting the plum).
Oyster-shell Bark-louse (see Insects affecting the apple).
San Jose Scale (see Insects affecting the peach).

INSECTS AFFECTING THE FOLIAGE.

The Four-lined Leaf-bug. (*Pœcilocapsus lineatus.*)

Shortly after the leaves appear on our currant and gooseberry bushes, we sometimes find small, wingless, scarlet bugs of a rounded form, and very active in their habits, running about and hiding away under the leaves, which become curled in consequence of their attack. These little bugs belong to the family of leaf-bugs, and later develop into winged forms of a black and yellow color. During all the stages, these bugs feed on the juices of plants, drawing them from beneath the surfaces of the leaves by means of long sharp beaks. The effect on the foliage is first to cause it to curl, and later to kill a little patch of the leaf substance about each point where the beak has been inserted. Such leaves appear spotted, the injured dots losing color and becoming brown. The adult bug is about five-sixteenth of an inch long, bright yellow, with four longitudinal, black stripes running about two-thirds of the way down the back. The winter is passed in the egg stage, in a slit cut in the side of a twig, usually not far from the tip. Several eggs are thus placed in a row. In the spring, the eggs hatch and tiny red bugs appear, which grow larger and larger by successive molts until finally the adult stage is reached, this stage being yellow and black in color.

Fig. 35.—Four-lined Leaf-bug, after Davis.

REMEDIES.

After these creatures become full grown and acquire wings, they are very difficult to control by any methods at our command, but while still immature and before they change from the red coat to the yellow and black one, they may readily be killed by a spray of kerosene-emulsion forcibly applied. This is best done with a nozzle set at right angles to the hose. Such an arrangement is easily prepared by using an elbow just behind the nozzle. With such a nozzle, one can spray upward from beneath, and that very forcibly and economically if a good nozzle be selected. Watch out for the bugs just as soon as the leaves expand, and kill them early. Use kerosene-emulsion, tobacco-water or some other good contact insecticide. When doing winter pruning, remove and burn all of the material which is cut out.

The Currant Span-worm. (*Eufitchia ribearia.*)

Unlike the larvæ of the imported currant-worm, those of the span-worm are measuring-worms or loopers, sometimes called inch-worms. All are familiar with caterpillars of this class. The currant span-worm often comes in large numbers, and devours the foliage very rapidly. The caterpillar, when full grown, is marked with three longitudinal yellowish stripes and by several

Fig. 36.—Currant Span worm, from Riley, Ninth Rep. State Entomologist of Mo.

spots on each segment. The pupal stage is passed under the surface of the soil, and the delicate, yellowish moth lays the eggs in summer for the brood of larvæ which will come out next spring about the time that the foliage becomes well grown. This insect works also on gooseberry. There is but one brood each year.

REMEDIES.

When the larvæ are noticed early before the fruit is more than just set, paris-green applied in the ordinary way, will kill them very nicely. After the fruit gets started, use hellebore in place of paris-green, because it is much safer.

The Imported Currant-worm. (*Nematus ribesii.*)

The common currant-worm is the larva or false-caterpillar of a saw-fly. Saw-flies belong to the same order as the wasps, but in place of stings, they are provided with saw-like implements with which they are enabled to cut slits in the foliage or bark of vegetation. They are mostly small, thick-waisted creatures with four wings, the color being often black or yellowish.

The saw-fly under consideration, lays its eggs in rows along the ribs of currant or gooseberry leaves where they absorb water and become swollen, afterward hatching into small, whitish false-caterpillars, which turn green after a time. Later, many black dots appear on the body, and just before they are ready to spin up in a cocoon, they change once more to green with yellowish extremities. The larvæ of saw-flies may always be distinguished, from those of moths and butterflies, by the number of feet, there being always six true, jointed legs and twelve to sixteen false legs; while true caterpillars with very few exceptions have only ten false legs.

When full grown the larva spins a cocoon, usually in rubbish near the base of the plant, although they may go just beneath the surface of the soil. The

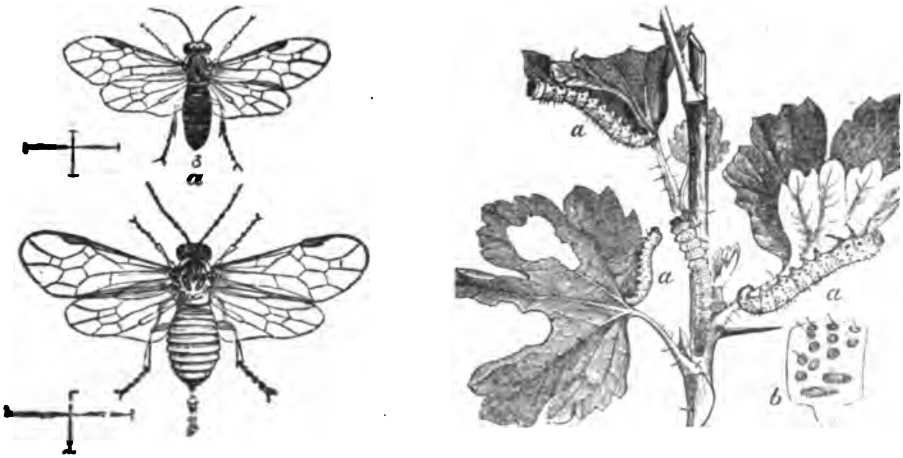

Fig. 37.—Imported Currant-worm, from Riley, Ninth Rep. State Entomologist of Mo.

cocoon is oval in form and thin, being papery in texture. There are two broods a year but they are not well defined. The adults come out at various periods, necessitating a repetition of the measures required to kill the larvæ.

REMEDIES.

The time honored practice of dusting with hellebore will ordinarily prove sufficient if the hellebore be fresh. After the fruit has been picked, arsenites may be used to advantage. See directions for using paris-green.

The Native Currant Saw-fly. (*Gymnonychus appendiculatus.*)

Another species of currant-worm which is a native of America is sometimes met, especially in the north. It occurs somewhat later than the imported species and the larvæe are green. The same remedies as those used against the imported species will apply.

AFFECTING THE FOLIAGE.

Fall Web-worm (see Insects affecting the apple).

INSECTS AFFECTING THE GRAPE.

AFFECTING THE ROOTS.

The Grape-vine Phylloxera. (*Phylloxera vastatrix.*)

The grape phylloxera is a native of America, where it has worked from time immemorial on the wild grape. This louse, in common with many other insects, does little injury in its native home. In Europe it is the worst enemy of the grape and here in America it is a serious enemy only to grapes of European origin.

The presence of phylloxera is made known by small galls on the under side of the leaves, and by somewhat similar galls on the roots. These galls if cut open early in their growth, are found to contain small plant lice, the galls on the roots eventually rotting out with a good portion of the rootlets, finally destroying the whole root system and leading to the death of the vine.

The insect occurs in four forms; the leaf-inhabiting form, the root-inhabiting form, the winged form and the sexual form. Winged lice appear when the colonies become crowded, and thus provide for the spread of the species and the founding of new colonies. It very often happens that the leaf-inhabiting form is quite numerous while the root-inhabiting form is not in evidence, furthermore the reverse is often true.

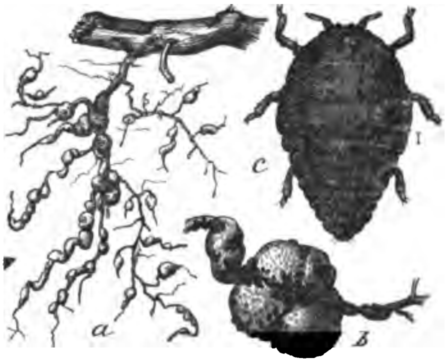

Fig. 38.—Grape Phylloxera, after Marlatt. Farmer's Bul. 70, U. S. Dept. Agr., Div. of Ent

The most effective method of combating this foe is by grafting the vine on resistent native stocks. This method promises the best results in a general way. The practice of flooding the vineyard for thirty days in the winter time is practiced in France where possible, but only in rare instances is this feasible here. Planting in almost pure sand is said to be very efficacious and the use of carbon-bisulphide is sometimes resorted to when the injury is very serious, three doses of one-fourth of an ounce each, of the liquid being injected into each square meter (about one and one-fifth square yards). For those intending to use carbon-bisulphide, it will be well to consult Johnson's "Fumigation Methods," published by the Orange Judd Company, see pages 262 to 267. The effects of different soils, depth of soil, and moisture are very carefully treated.

The Grape-vine Root-worm. (*Fidia viticida.*)

This first-class pest is included here not because it is at present working in Michigan, so far as is known to the writer, but because it is to be expected at

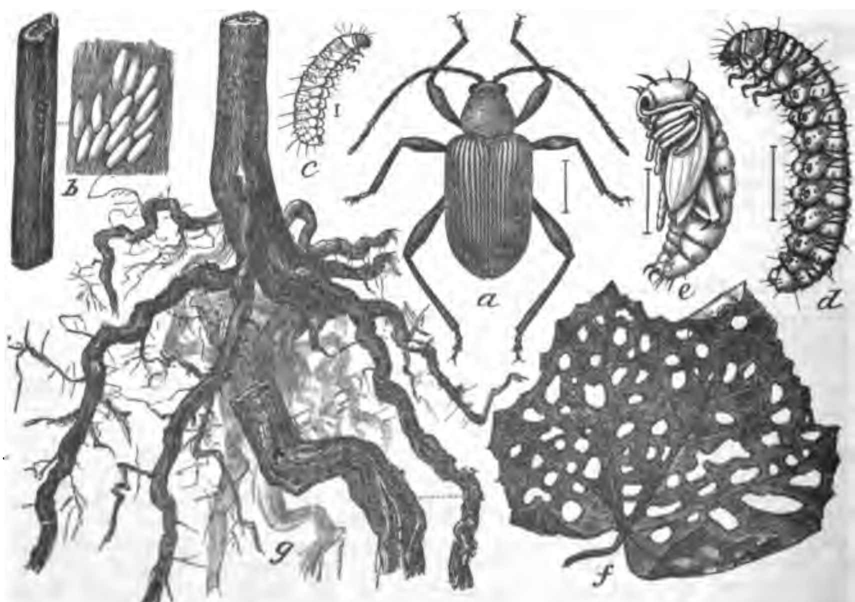

Fig. 39.—Grape-vine Fidia, Farmer's Bul. No. 70, Marlatt, U. S. Div. of Ent. Dept. of Agr.

any time, being already in Ohio and Illinois. It has shown itself capable of inflicting great injury, especially in neglected vineyards. The beetle is about one-fourth of an inch long, brown in color, and with a rather dense covering of whitish hairs.

The damage is done by both adults and larvæ,—the beetles working on the foliage, and the larvæ on the roots. The adults eat holes in the leaves in July and August, laying their eggs under the loose bark of the vines. The eggs hatch, fall to the ground, and the grubs find their way to the roots, where they remain until the following June, when they change to pupæ, making cells in the soil by packing hard the sides of the spaces in which they lie. In June and July, the pupæ change to adults, which commence eating holes in the leaves.

REMEDIES.

Many experiments have been tried in hopes of finding some method whereby the pests could be cheaply and effectively combated, and while they do respond to treatment it is not an easy matter to keep them under control when once they get a start. The following methods are said to be useful:

Jarring.—Jarring the insects into pans or canvass frames made for the purpose and then shaking them into kerosene. This method is more or less expensive at present, but quite effective.

Spraying.—Paris-green should kill the adults, and if applied as soon as the beetles appear, and before the eggs are laid, should be of great value.

Deep rooting.—The beetles prefer to work near the surface and deep rooting is said to be of benefit.

Resistant stocks.—The use of stocks more or less distasteful to the beetles should yield good results. Experiments are being at present carried on by the Cornell Experiment Station to determine the value of various native stocks.

Cultivation—Professor Slingerland recommends persistent cultivation during the period of pupation. The little creatures are easily destroyed by breaking open their cells, and many of them are either buried deeply or exposed on the surface to the ravages of birds, shrews, etc. The cultivation for this purpose should be done from June 15th to the 25th, according to Professor Slingerland, in New York. Probably the same dates will apply here. It is hoped that specimens of this insect will be forwarded to the entomologist as soon as found, in order to follow its spread and to provide for experiments for its control.

The Giant, Grape Root-borer. (*Prionis laticollis.*)

The figure represents a large, soft larva, which goes by the name of the giant, grape root-borer. This footless creature is the larval form of a stout,

Fig. 40.—The Giant, Grape Root-borer, from Riley, Second Rep. State Entomologist of Mo.

black beetle, belonging to the family of long horned wood-borers. The larva is white in color, with a brown and black head, and with a row of oval, brown spots running down each side of the body. It bores into the roots of many trees and shrubs, seeming to prefer those of grape whenever accessible. One readily can imagine that when a hole is bored through a grape root by an insect of this size, some injury is apt to result. Fortunately it is only occasionally that one hears of its depredations. The only remedy known is to dig down and cut out the larva whenever the vines show its presence.

AFFECTING THE CANES.

The Grape Cane-borer. (*Amphicerus bicaudatus.*)

Early in the spring, the young shoots of grape-vines, as well as those of apple, pear, and sometimes those of peach and plum trees, are sometimes found to be dying back for some little distance from the tip. An examination shows a

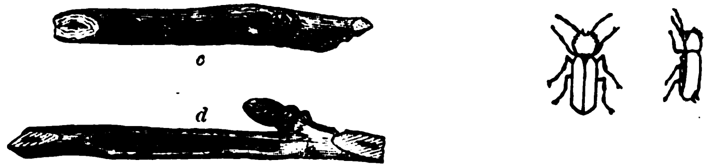

Fig. 41.—Apple Twig-borer or Grape Cane-borer and its work, from Riley, Third Rep. State Entomologist of Mo.

smooth, round burrow extending several inches from a neat opening which usually is placed in the axil of a bud. This is the work of the grape cane-borer, otherwise known as the apple-twig borer, the culprit is often found within the burrow, it is a long slender beetle dull brown in color. As the insect breeds in quite different quarters, it is difficult to conceive the object in thus tunneling the twigs. The work is shown by the wilting of the young leaves, due to the death of the cane or twig. The beetles are one-brooded.

REMEDIES.

Cut out all twigs containing burrows, or if the cane be large and seemingly strong enough to withstand the injury, kill the beetle with a slender wire. Remove and burn all cuttings and dead or dying wood from the vineyard, orchard, or vicinity, as the beetle breeds in such places.

The Cottony Maple Scale. (*Pulvinaria innumerabilis.*)

Fig. 42.—Cottony Maple Scale on grape. Original.

During the first half of the season, one often finds on the grape-vines, large brown scales, each scale being tilted up somewhat at one end by a mass of viscid cottony material secreted there. This mass of filaments is the nest in which the eggs are laid. After a time the eggs hatch, the young lice make their way to the under side of the leaves, and the nest is blown out by the wind into long streamers like cobwebs. Later in the season, after the young become about half grown, the females migrate back to the twigs, and the males meet them

and die. Here on the twigs the females settle for winter in a partially grown condition. In the spring, they rapidly complete their growth, lay batches of eggs and dry up. The insect works on a number of other plants and trees, loving especially the soft maple.

REMEDIES.

When only a few are present, they may be scraped off the vines with a knife, but when they occur in large numbers it is necessary to use a spray. Apply kerosene-emulsion just after the young hatch in June and July, diluting the emulsion about eight times, or else spray in the winter time with one of the contact insecticides recommended for the San Jose scale.

Apricot-scale (see Insects affecting the plum).
Tree Cricket (see Insects affecting the blackberry).

AFFECTING THE FOLIAGE.

The Grape Leaf-hopper. (*Erythroneura vitis.*)

One of the most destructive grape insects in this part of the country, is the leaf hopper, sometimes erroneously called the thrip. Almost minute in its dimensions, measuring scarcely more than an eighth of an inch in length, inconspicuous, jumping and flying away on the slightest disturbance, it hardly seems possible for so small a creature to work such havoc. It occurs in great numbers, literally in great swarms. The prevailing colors are yellowish-white and bright red. The insect is many brooded, the eggs being placed in cavities cut in the leaf. The work

Fig. 43.—Grape Leaf hopper, from Saunder's Insects Injurious to Fruits.

of the leaf hopper shows in browned and curled leaves, and consequent poor fruit. The writer has seen whole regions of vineyards where the foliage appeared as if scorched, just such a result as might be brought about by continued hot winds. The damage in such cases is very severe.

REMEDIES.

The insect passes the winter in rubbish, under leaves, and in all sorts of neglected situations. The removal of such rubbish late in the fall, after the insects have taken up winter quarters, will work wonders. Sometimes it is possible to burn over grass and rubbish on the edges of vineyards, destroying immense numbers and lessening the next year's supply.

The writer has obtained some results by spraying with strong tobacco-extracts, which act as repellants, but such sprays are expensive and give only partial immunity. The most promising remedy is one devised by Professor Slingerland of Cornell. He found that by applying a weak spray of kerosene and water emulsified by a mechanical mixer (a knapsack pump which takes the oil from one tank and the water from another and mixes them in any proportion), he could easily knock the insects off the vines on to the ground, and then by changing the proportion of oil in the spray to strong emulsion, he could spray the insects on the ground and kill them. The difficulty lies in the fact that the insects will stand a good strong emulsion such as is ordinarily used, and in order to kill them direct, it becomes necessary to use a spray stronger than the vines will stand. In this double spray, which is cheap, we have an effective remedy.

The Gartered Plume-moth. (*Oxyptilus periscelidactylus.*)

This curious little creature is common enough in our State, although it rarely occurs in sufficient numbers to be serious. The larvæ are small, yellowish-green in color, and about half an inch long. They bind some of the small leaves together, making a little nest in which they feed and pupate. The moth is small and very lively. The front wings are cleft almost half way to the base, the hind wings being cut deeper still. Hand picking is the best remedy when they become numerous.

Hawk-moths. (*Darapsa myron, Philampelus pandorus, P. achemon, Thyreus abotii, Deilophila lineata,* and others.)

A number of species of hawk-moths or humming-bird moths pass their larval stage on the grape. The larvæ of these moths are good sized caterpillars, each having a strong, spike-shaped process or tail on the upper part of the posterior end. In the case of some species this spike is replaced, in the older examples, by a polished tubercle resembling an eye. They work openly, feeding on the foliage, and doing a great deal of damage in a short time. The pupal stage is passed under-ground, the pupa usually being more or less cigar-shaped and sometimes as large around as a cigar. The larvæ are so large and conspicuous, and the work and excrement so easily seen, that it is quite an easy matter to kill them by hand. In fact hand picking is the only practical remedy, as they do not readily succumb to the poisons.

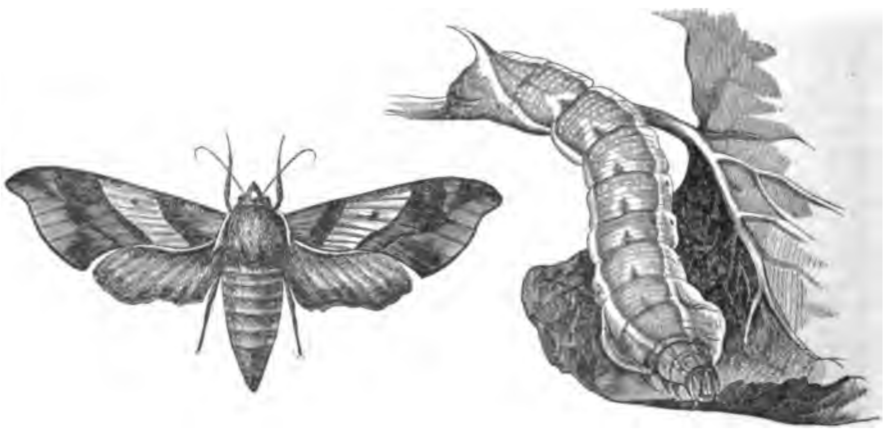

Fig. 44.—The Grape-vine Hawk-moth, after Riley, American Entomologist.

The Grape Leaf-roller. (*Desmia maculalis.*)

The grape leaf roller is a beautiful little moth, measuring about an inch from tip to tip of the extended wings. It is iridescent black, and each wing has two conspicuous white spots. In the male, the two spots of the hind-wing unite into one elongated mark. The larva folds the leaf of grape, and feeds on the surface inside the fold, skeletonizing the leaf, later the pupal stage is passed either in the large fold, or in a smaller one made for the purpose. There are said to be two broods a year in the North.

REMEDIES.

Hand picking is the most effective remedy. The work is conspicuous and the picking can be cheaply done. Clean culture or the removal of rubbish, will do away with many of the hibernating pupæ.

The Rose-chafer. (*Macrodactylus subspinosus.*)

The rose-chafer, or rose-bug, is a small beetle with long, awkward legs and a voracious appetite. They come in swarms, almost covering grape vines, fruit trees, roses, ornamental shrubs, etc. They are worst in sandy regions, appearing about the time that the grapes bloom. The beetle is about three-eighths of an inch long, light yellowish-brown in color, and has long reddish legs. The habits of this destructive insect are fully described by Dr. Marlatt of our National Department of Agriculture.

Dr. Marlatt says,* "It passes its early stages in grass or meadow land, especially if sandy,—the larvæ feeding on the roots of grasses a few inches below the surface of the ground like the common white grub which they closely resemble except in size. The eggs are laid on the ground in June and July, and the larvæ become full grown by autumn and transform to pupæ the following spring, from two to four weeks prior to the emergence of the beetles."

REMEDIES.

Nothing in the way of a spray seems to be efficient. When in small numbers, the arsenites may prove of benefit, though the beetles usually keep coming so fast that it is difficult to make sure that there is any real benefit. Arsenites act slowly on these sluggish pests and new hosts are apt to replace those killed by the poison.

Dr. Marlatt advises the use of spirea as a trap plant. The beetles dearly love spirea and will gather on the shrub in preference to anything else. From the trap plants they may be knocked into pans containing water and kerosene, or into an inverted umbrella wet with coal oil. Dr. Marlatt says (loc. cit.), "The number of rose-chafers may be considerably limited by restricting the areas in which they breed,—all sandy meadow land especially should be broken up and cultivated to annual crops, and the more general the cultivation of all lands the fewer will be the rose-chafers. In this procedure notable results may only be secured by the cooperation of a neighborhood."

The writer has long felt that results might be obtained by knocking the beetles into long shallow sheet-iron pans, when the trouble is with the grape, at any rate. These pans can be made of an entire sheet of sheet-iron, about twelve feet long by two feet wide, by simply bending up a border of about two inches all the way around. Braces should of course be put on the bottom and handles at the ends. Then by spreading rags soaked in water in the bottom of the pan and pouring kerosene over all, a death trap or beetle dozer is made ready. Such a dozer should be placed parallel to a row of vines and the beetles knocked into it by brushes made of pine twigs. Such brushes should tear the foliage only to a minimum degree. The beetles after coming in contact with the oil may crawl away or they may remain in the pan, it makes no difference, for they will shortly die.

The dozer may be drawn along by means of a rope and another set of vines beaten, the stupidity of the beetles making them loath to fly. Of course such a method will have to be persisted in if success is to be attained. One treatment will not end the matter, nor will all the beetles be killed at any one treatment. It does however promise well for the man who is willing to keep up a continuous fight during the few weeks of the invasion.

The Light-loving Anomala. (*Anomala lucicola.*)

We occasionally see on our grape vines, medium sized cock-chafers, resembling June-beetles, only smaller. They measure about one-third of an inch long, and vary in color from brownish to yellowish-brown and even black. The common form has brownish-yellow wing-covers and a dark thorax, usually with a border the color of the wing-covers. These beetles are said also to feed on the Virginia creeper. From time to time they become numerous enough to entirely skeletonize the foliage. The larval and pupal stages are passed in the soil. They resemble the small white grubs and pupæ of the June-beetle very much except in size.

* Farmer's Bulletin No. 70, U. S. Department of Agriculture; also, year book for 1895.

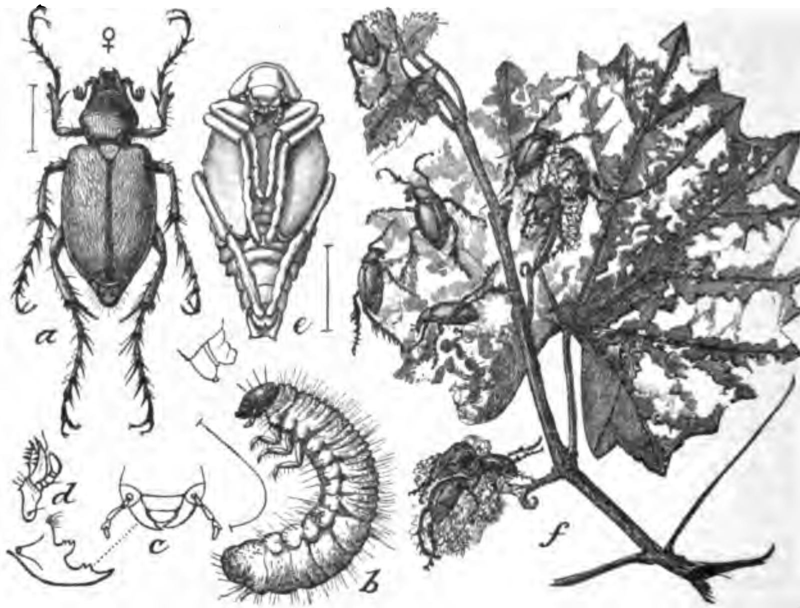

Fig. 45.—Rose-chafer, from Marlatt, Farmer's Bul. No. 70, Div. of Entomology, U. S. Dept. of Agr.

REMEDIES.

A spray of Paris-green applied in the ordinary way except when the fruit is set, when hellebore must be substituted.

The Grape-vine Flea-beetle. (*Haltica chalybea.*)

One of the constant enemies of the vineyard is the grape-vine flea-beetle, a little steel-blue, oval creature, highly polished and with the habit of falling to the ground on the slightest disturbance.

This little beetle is about three-twentieths of an inch long. It passes the winter in the adult condition, and in early spring attacks the swelling buds of

Fig. 46.—The Grape-vine Flea-beetle, from Riley, Third Rep. State Entomologist of Mo.

the grape. It also eats the foliage as it appears, depositing orange colored eggs on the under-side of the leaves. The eggs hatch out into small, brown larvæ, which feed on the leaves riddling them with holes. In June, these larvæ descend into the ground and pupate, emerging as the second brood of adults in late June or July. The same life-history is repeated once more, the adults secreting themselves late in the fall, in rubbish, under bark, etc.

REMEDIES.

Paris-green.—Spray just as the buds swell with Paris-green and lime, putting it on strong, one pound of the poison to seventy-five gallons of water. Later,

before the fruit gets started, put on another spray or two, diluting to one pound of the poison to one hundred and seventy-five gallons of water.

Clean culture.—As the beetles winter in rubbish, etc., rake up the rubbish very early in the spring and burn or bury.

The beetles also feed on elm and several other plants.

The Spotted Pelidnota. (*Pelidnota punctata.*)

Conspicuous among the enemies of the grape, is a large brownish-yellow beetle with three black dots on each wing-cover. Heavily, and with a droning flight, this large beetle wanders about among the vines with no attempt at con-

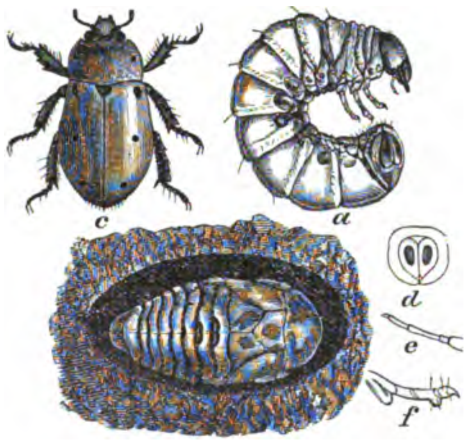

Fig. 47.—Grape Pelidnota, after Riley, American Entomologist.

cealment, feeding on the foliage. Usually, however, their numbers are small and little harm is done in proportion to the threatened damage. The larval and pupal stages are passed in rotting wood, the larvæ somewhat resembling those of the June-beetle. When very numerous, they may be controlled by hand-picking, the damage being confined to that inflicted by the adult beetle.

Climbing Cut-worms (see Insects affecting the peach).
Phylloxera (see Insects affecting the roots of grape).
Grape Root-worm (see Insects affecting the roots of grape).

AFFECTING THE FRUIT.

The Grape Berry-moth. (*Eudemis botrana.*)

A small moth, spreading a little less than one-half inch, that works on the ripening fruit. It has not been reported as injurious from Michigan as yet, though it is sure to be sooner or later. The larva bores through the green grape, often fastening several shriveled and blackened grapes together. The early broods are said to work on the foliage and young fruit, and the pupal condition is said to be passed in a fold cut in the leaf.

REMEDIES.

Collect all injured and fallen fruit and destroy. Destroy also all fallen leaves in the autumn. In cases where it is feasible, bag the clusters. Of course this will pay only in case of very choice and high-priced varieties.

INSECTS AFFECTING THE PEACH TREE.

AFFECTING THE ROOTS.

The Peach Borer. (*Sanninoidea exitiosa.*)

By far the worst enemy of the peach, in Michigan, is the peach borer. This insect is said to work also in cherry, plum, prune, nectarine, apricot, flowering almond, and azalia. The adult is a small moth having partially clear wings and ornamented with metallic blue and orange scales. According to Professor Slingerland, the eggs are laid between June 15th and October 1st on the bark. The larvæ or borers, that do the injury, are soft bodied, and for the most part white in color. The head and legs are brown. They work at first in the bark,

Fig. 48.—The Peach Borer, from Riley, First Rep. State Entomologist of Mo.

and later between the bark and wood near the crown, usually a few inches beneath the level of the soil. In old trees, they may work on the trunk and even in the large branches. Their presence usually is made known by a copious exudation of gum The winter is passed in the larval condition; some times the larvæ or "worms" being nearly full grown, and they range from that down to a very small size. In the spring, they resume feeding, attain their growth, and spin cocoons near the tunnel or burrow. The cocoon is made of silk with frass and excrement woven in on the outside. About the middle of June, the adults commence to emerge from these cocoons, and soon the first eggs are laid for the next brood. If the adults all came out together, and the eggs all hatched about the same time, we might hope to gain control with ordinary measures but the period of egg laying extends through September, according to Professor Slingerland, therefore all measures except that of hand digging or "worming" must be extended over long periods.*

REMEDIES.

The time honored measure of digging away the earth from the crown and of making a careful examination of each tree, has never been superseded by one more effective to say the least. The removal of the larvæ in the spring or fall by the knife, of course settles the matter for the time. The presence of the larvæ usually is indicated by a mass of gum. Professor Slingerland in his exhaustive work on this insect, describes how he tried every thing that seems to have been recommended for this pest, and succeeded in finding a long list of useless "remedies." He found, however, that tobacco waste placed close to the tree, at the level of the soil, did prevent a good percentage from gaining lodgment. He also obtained partial immunity by wrapping paper about the crown and lower trunk and tying with an ordinary string.

The writer has been assured by several peach raisers in Western Michigan that the practice of digging away the soil from the upper roots, where the worms burrow, in June, results in destroying the larvæ and pupæ, the sun shining directly on the parts and killing the tender creatures. The soil is turned back in midsummer by the ordinary cultivation. Still others practice heaping up the soil about the trunk for eight or ten inches in the spring thus inducing the larvæ to work high up. These banks are removed in the fall and the trees wormed in the ordinary way.

* Bul. No. 176, Cornell Exp. Sta., Dec., 1899.

AFFECTING THE TWIGS.

The Peach Twig-borer. (*Anarsia lineatella.*)

An insect of minor importance with us, is the peach twig-borer. It works in Michigan on the peach and is said to attack other fruits also in California. Although several broods are raised each year, most of the damage is done by the brood which matures in late April and early May. The larvæ bore into the new

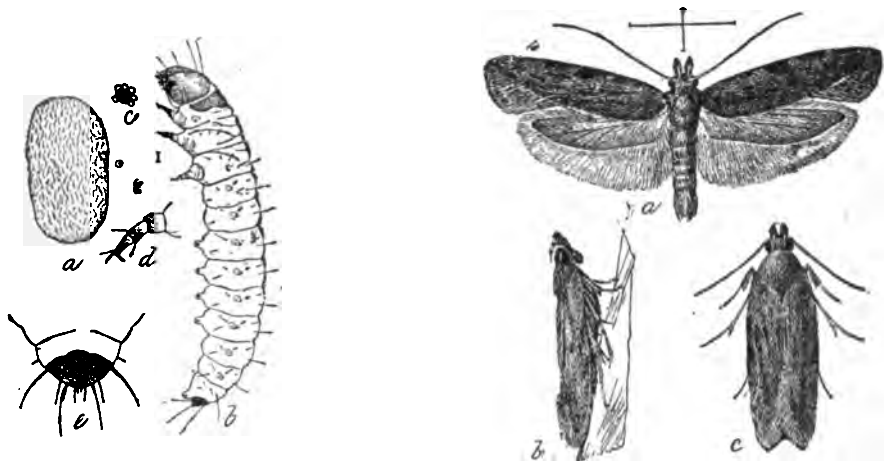

Fig. 49.—Peach-twig-borer, after Marlatt, Farmer's Bul. No. 80, U. S. Dept. of Agr. Div. of Entomology.

growth, killing the terminals and injuring the branches, sometimes destroying a considerable portion. Later broods are said to feed in the bark and in the fruit stems, sometimes boring into the fruit, the last brood tunnelling while very small into the thickened bark in the axils of small twigs. Here they are said to make minute tunnels lined with silk. In this condition the winter is passed and this is the brood which comes out in the spring and attacks the twigs.

REMEDIES.

Experiments in California by Mr. Warren T. Clark,* seems to show that the twig-borer may be controlled by a spray of lime, salt and sulphur, applied just as the buds commence to swell, but before they open in the spring. The spray catches them during their migration to the new growth.

Buffalo Tree-hopper (see Insects affecting the apple).
Tree Crickets (see Insects affecting the blackberry).

AFFECTING THE TRUNK.

Flat-headed Apple-tree Borer (see Insects affecting the apple).
Divaricate Buprestid (see Insects affecting the cherry).

AFFECTING THE BARK.

The San Jose Scale. (*Aspidiotus perniciosus.*)

One of the worst fruit and shade-tree pests with which we have to contend, is the San Jose scale, feeding, as it does, on a long list of plants and trees, and bringing about such grave results, it always enforces serious consideration.
Individuals belonging to this species are minute. They are protected by a

*Bul. No. 144, Cal. Agr. Exp. Sta.

Fig. 50.—San Jose Scale from Howard and Marlatt, Bul. No 3, new series, Div. of Entomology, U. S. Dept. of Agr.

thin, papery covering or scale, free from the body. The female scale being grey in color, usually with a yellow or orange central spot where the exuviæ or cast-skins are placed. The male scale is circular at first, with a central raised nipple and an elevated ring about it. When fully developed, the male scale becomes elongated by a growth at one side. Fig. 51 gives a good idea of the appearance of the scales of both sexes.

If the bark under a colony of such scales be scraped off, the deeper layers often show a purple staining. Fruit also is often stained in this manner. This staining, however, must not be taken as positive evidence, for several other scale-insects sometimes produce the same coloring. The females always remain attached to the twig, but the males are winged when adult.

The young of this species are born alive and several broods are produced each year, so that under favorable circumstances, the rate of increase may be very rapid indeed. As the insects become fixed very early in their lives, the spread of a colony and the foundation of new colonies must take place during the first stage, or just after birth. At that time they are very minute appearing as small as grains of sand. They are active for a few hours, however, and during that time, they run about from one part of the tree to another. They also probably crawl upon the feet of birds and upon other insects, and are by them transported to new quarters.

REMEDIES.

Many sprays have been tried for the extermination of this pest. In the West, fumigation under tents is also used. We find at least three sprays effective and practical here. Perhaps, in view of the cheapness and the ease with which it is correctly made, we may place lime-salt and sulphur as first in the list. Directions for making and applying all of them will be found in the chapter on insecticides. All of these sprays must be applied during the winter season, while the trees are dormant, or else they are almost sure to injure the trees. Next comes kerosene emulsion, diluted so that one part of oil is used with four parts of water, or so that the oil forms 20 per cent of the spray when ready to apply; and last, because it is the most expensive, is whale-oil soap, a very effective spray when used at the rate of two pounds to a gallon of water. Other sprays are useful, but these three seem to give the best satisfaction. Strong potash kills a goodly proportion of the insects and it cleans the bark, giving it a fresh, healthy appearance, but it is quite expensive and does not seem to kill quite so large a proportion of the insects as the others. Kerosene and water, applied with a mixing pump (a special pump that takes the water from one tank and the oil from another, mixing them

in their passage through the pump), is not entirely satisfactory as yet, the emulsion is safer and very much more uniform. The use of the mixture has not yet passed out of the experimental stage.

Any scale that is suspected of being the San Jose scale, should be sent to the entomologist for identification. If it is really the San Jose scale, the owner should know it immediately, and if it is comparatively harmless, the knowledge that it is so, will save a good deal of worry.

The English Walnut Scale. (*Aspidiotus juglans-regiæ.*)

Although this pest undoubtedly works on English-walnut it is of far more importance to us in Michigan because of its love for peach, plum and other trees. The description of the European fruit scale will apply fairly well to this pest. It is usually somewhat larger than the latter, but in general the scales look much alike. This pest may be classed as somewhat less dangerous than the fruit scale. The same remedies as those recommended for the San Jose scale will apply in this case.

The Peach Lecanium. (*Lecanium nigrofasciatum.*)

For many years the peach Lecanium has flourished, especially to the south of us. It is a small Lecanium, about an eighth of an inch long and one-sixteenth of

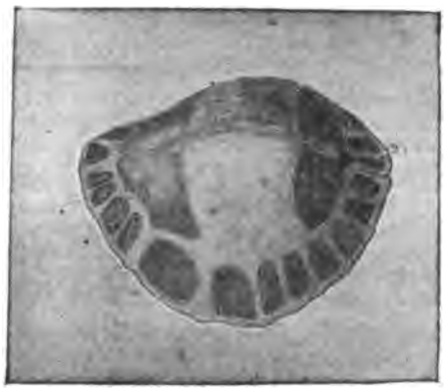

Fig. 52.—Peach Scale, Author's illustration.

an inch broad. The scale is reddish-brown and oval. The top of the scale is lighter in color than the sides, and there are about twelve radiating lines on each side dividing the border into dark areas; see Fig. 52. When just acquiring full size, the colors are very bright, brown and black with flaming red.

These scales cluster on the twigs of peach, soft maple and a number of other trees and shrubs, frequently doing a great deal of injury.

REMEDIES.

The usual winter sprays, applied for the San Jose scale, or a spray of kerosene-emulsion, diluted about eight times, during late June or early July, when the eggs hatch.

The Fruit Bark-beetle. (*Scolytus rugulosus.*)

The fruit bark-beetle is a small beetle which works between the bark and wood of peach, apple, pear and cherry. The first intimation of the presence of this pest usually comes when the owner discovers that some trees have many small round holes in the bark, appearing very much as if a light charge of fine bird shot had been fired into the trees. If the outer bark be carefully pared down, in such a case, the tunnels from which the holes spring will appear. First there will be a short and broad brood-chamber with an opening to the surface at one

end, and radiating from the side of the brood-chamber will be many long slender tunnels which gradually increase in size as they get farther and farther away from the brood-chamber. At the distal end of each of the long burrows will be a deeper excavation and connecting with that, an opening to the surface. The original brood-chamber is made by the parent beetles, and along each side, the female lays a row of eggs. The young grubs from the eggs burrow out away from the chamber between the bark and the wood, the size of the grub, and therefore of the

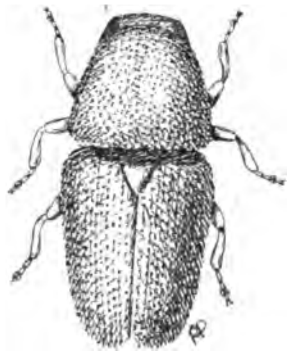

Fig. 53.—Fruit-bark beetle, enlarged. Author's illustration.

burrow increasing as they get farther and farther away from the brood-chamber. When full grown they make deeper cavities in which they pupate and from which they afterward emerge through the small round holes to the surface. When the work is fresh, there is an exudation of small drops of gum which become conspicuous and lead to the detection of the trouble. The tree becomes sickly in appearance and as a rule finally dies.

The beetle which is the cause of all this trouble, is very small, a little more than one-sixteenth of an inch in length, rough, and almost cylindrical. There are several broods each year.

Fig. 54.—Tunnels in the branches. Author's illustration.

REMEDIES.

The insect belongs to the family of engraver-beetles and all members of this family prefer to work in dying, or at least, unhealthy trees. They are much more likely to do injury in neglected orchards than in those that are well cared

for, but this is not invariably the case. The writer has in mind a man who is very conscientious, but who has suffered considerable loss among young trees, especially those of peach.

As a rule stimulation of unaffected trees, and the removal and burning of badly infested ones, will check the trouble. It is well to use a liberal coat of whitewash on the trunks and large limbs.

If the insect appears, prune if the trees at all need it; fertilize well and cultivate. Use commercial fertilizers if necessary, and do everything possible to get the trees in a healthy vigorous condition. Take out badly affected trees and burn them. Advantage may be taken of the preference of the beetles for sickly trees, and if any worthless or comparatively poor trees are in the orchard, girdle them in mid-summer and thus induce the beetles to take possession. This will serve as a trap to attract many beetles to one spot. The trees must be removed and burned before the middle of the following June in order to destroy the beetles before they emerge and commence to lay eggs. When a tree is slightly attacked, the bark may be pared where the trouble is the worst, and as a matter of prevention, whitewash, to which a little Paris-green has been added, may be used on the trunk and larger limbs. These measures, while not perfectly satisfactory, will serve to restrict the trouble in many cases. We live in hopes that a more perfect remedy will shortly be discovered.

Eccentric Scale (see Insects affecting the apple).

AFFECTING THE FOLIAGE.

The Black Peach-aphis. (*Aphis persicae-niger.*)

The black peach-aphis was first recognized in Michigan in 1889 by Dr. Erwin F. Smith. Like the woolly-louse of the apple, it works both on foliage and on the roots.

The louse is small, highly polished, and with a metallic lustre. The aerial form is black, with a ventral surface dark brown. The root-inhabiting form, dark brownish black. They reproduce continuously during the summer without the production of eggs, the young being born alive.

The foliage of the infested trees is sickly in appearance, the leaves often being slightly curled. Eventually the tree dies, usually in a comparatively short time.

REMEDIES.

The danger of introducing this pest on young trees cannot be too strongly felt. If there is the slightest suspicion of the presence of the lice on nursery stock, dip in kerosene-emulsion or tobacco-water, after washing the soil carefully from the roots. Put in a liberal supply of tobacco-dust about the roots when setting out and keep a bright lookout for the first appearance of the lice. When it is necessary to take out a tree infested with these lice, do not set in another for a year or so. When so-called dead spots appear in the orchard, search for the pest and use a liberal supply of tobacco-dust dug in about the trees, remembering that the roots extend some distance from the trunk and that the fine rootlets are the ones most injured. Use unleached wood ashes when obtainable, or else kanite or some of the allied salty fertilizers. Tobacco-dust is very cheap and the safest and most practical remedy known to the writer.

Climbing Cutworms. (*Mamestra subjuncta* et al.)

There are among the cutworms, a number, perhaps a dozen or more, that make a practice of climbing fruit trees, grape vines, etc., and of eating out the opening buds and young foliage, often to the serious detriment of the tree. The peach tree is the one worst affected in Michigan, but young apple trees just set out, also suffer very severely. There are, as stated, several species of these cutworms and to describe them all so as to make them recognizable, would hardly be in place here. Their presence is usually detected by their works. Almost all cutworms work at night, and those that have developed the climbing habit are no exceptions. Usually the first intimation of their presence occurs when certain parts of the trees fail to put forth young leaves, or else when such young foliage disappears, usually a whole branch at a time, if the infestation be slight,

or the whole tree if the tree be small and the cutworms numerous. In the case of the peach, the blossoms are often eaten, a hole being made through the side of the calyx, and the ovule of the young peach taken out. The proper course to take under such circumstances, is to go to the infested places at night with a lantern, and to watch carefully with a dim light for the culprits.

The adults of these pests are moths of medium size, the wings spreading perhaps an inch or an inch and a half. They are of various colors and all are night fliers. They are known as owlet-moths.

The eggs of these cutworms are laid in various places; often in sod land or wherever appropriate food is to be had, late in summer or early in the fall, and the young cutworms that hatch out, become partially grown before winter sets in, hibernating in this condition. In the spring they awaken with a very healthy appetite, and attack weeds, grass or anything that offers. In some species, the eggs are laid in the spring, and in still others the winter is passed in the egg stage. A greater number, however, pass the winter as partially grown larvæ. In the case of an orchard newly planted on sod land, the destruction may be very rapid and complete as there is little else to be had—of course all our Michigan orchards are well cultivated.

Fig. 55.—Cut-worm, showing larva, pupa and adult, from Saunders, Insects Injurious to Fruits.

Cutworms, of all kinds, migrate and will come into orchards and vineyards from good breeding places and make themselves at home very quickly. They are good travelers as a rule.

REMEDIES.

Where cutworms are suspected, plow late in the fall, before setting out a young orchard, thus burying many eggs or young "worms." The presence of some crop to the liking of the cutworms—something like rye—put in as late as possible and turned under when the foliage gets well grown, will furnish the worms something to eat and keep many of them out of the trees.

Banding.—A band of loose cotton-batting, tied around the trunk, just as is done for the canker worm, will prevent practically all of the worms from getting into the trees so long as the cotton keeps loose and fluffy. Unfortunately, it sometimes happens that the worms on being turned back by the band, commence to gnaw the bark just below the band and if the tree be a whip recently set, they often girdle it. Probably poisoned baits,—clover wet down with strong paris-green water and distributed in small heaps near the trees, will prove useful in such cases. The cutworms nearly always drop to the ground and cover themselves with soil during the day time, and the bunch of fresh clover offers a good hiding place for cutworms in general. After passing the day under such a covering, they are very apt to partake of some of the poisoned leaves before starting out in earnest for a meal. Poisoned bran mash has been recommended as being very effective when used in connection with the cotton bands. The figure shows how to put on a cotton band. It is passed around the tree and tied with a string around the bottom, the top is then turned down over the string and left spread out. Only one band is used, two being shown in the cut, in order to make clear the whole proceeding. It is very likely that narrow strips of sticky fly-paper fastened around the tree would catch many of the worms although the writer has never seen it tried. The difficulty will be that sand, blown by the wind, will be apt to form a crust on the surface if the bands be left without renewing too long.

Fig. 56.—Peach tree banded for Climbing Cut-worm, after Slingerland.

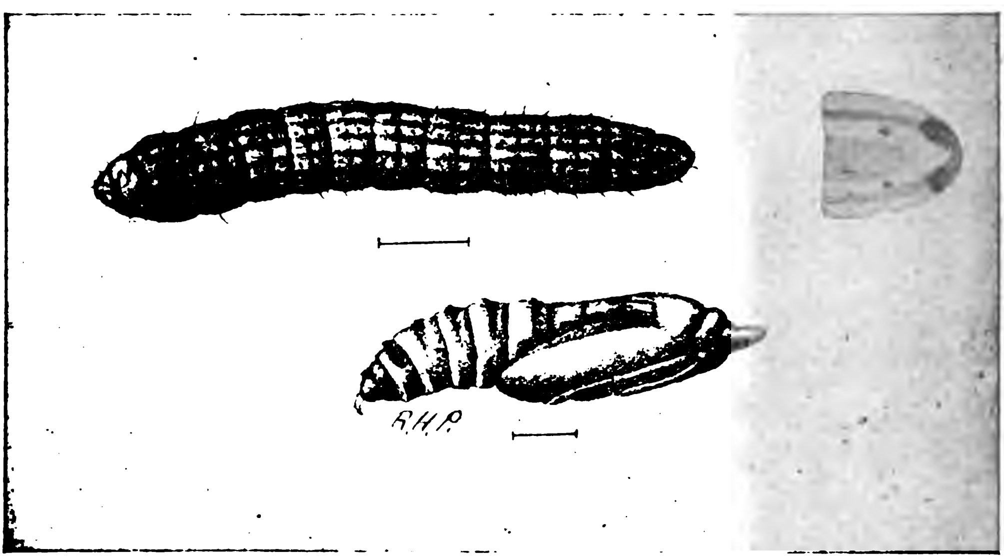

Fig. 57 —Striped Peach-worm, enlarged. Author's illustration.

The Striped Peach-worm. (*Gelechia confusella.*)

Occasionally an insect which is considered rare, is discovered working locally in such numbers as to do harm. Such is the case with the present species. It is to be found in the western part of the State in restricted areas.

The larva is striped, dirty white, with six longitudinal reddish-brown stripes, and with a yellowish-brown head and thorax. It is restless, wriggling violently when disturbed. It binds together the leaves of the peach with a web of fine silk, forming a nest of loosely bound leaves in which several live and in which they change to pupæ. They appear in Michigan about the first of July and again about the middle of September.

The adult moths are very dark in color, the front-wings being almost black with a purplish sheen. The hind-wings are lighter in color.

REMEDIES.

Two methods of treatment are found to be useful, cutting out and burning the nests, and spraying with arsenites just as the worms appear. Great care must be observed in putting paris-green on peach. Use lime according to directions and do not apply stronger than one pound to 180 or 200 gallons of water. Do not apply poisons for the late brood for the fruit will be too far advanced by that time.

AFFECTING THE FRUIT.

The Bumble Flower Beetle. (*Euphoria inda.*)

A thickset, awkward beetle, of dull color, somewhat resembling a small June beetle. It is two-brooded; one brood emerging in early spring, and the other in September. The name is suggested by the loud humming noise that it makes when on the wing, resembling closely the noise made by a bumble-bee. The members of the fall brood have the bad habit of tunneling into ripe fruit, nota-

Fig. 58.—Bumble Flower-beetle. Author's illustration.

bly peaches and pears, although grapes do not escape. There is really no satisfactory remedy known. Fortunately they are not commonly numerous enough to do very serious injury in more than small areas.

Codling-moth (see Insects affecting the apple).

Plum Curculio (see Insects affecting the plum).

INSECTS AFFECTING THE PEAR.

AFFECTING THE TRUNK.

Round-headed Apple-tree Borer (see Insects affecting the apple).
Flat-headed Apple-tree Borer (see Insects affecting the apple).

AFFECTING THE BARK.

Oyster-shell Bark-louse (see Insects affecting the apple).
Scurfy Bark-louse (see Insects affecting the apple).
San Jose Scale (see Insects affecting the peach).
Eccentric Scale (see Insects affecting the apple).
European Fruit-scale (see Insects affecting the plum).
Fruit Bark-beetles (see Insects affecting the peach).

AFFECTING THE BRANCHES.

Apple-twig or Grape-cane Borer (see Insects affecting the grape).

AFFECTING THE FOLIAGE.

The Pear Psylla. (*Psylla pyricola.*)

Fig. 59.—Pear Psylla, adult and nymph, enlarged, from Slingerland.

Occasionally we hear of trouble arising from the pear psylla, an European insect, which was first noticed in Michigan in 1891. The presence of this insect is usually indicated by a general loss of vitality in the tree, early in the season. The young growth droops, and sometimes considerable foliage and fruit drop from the tree. The leaves are seen to be smeared with honey-dew, which attracts ants and wasps, and which supports a black, sooty fungus later in the season.

The immature insects are very small, a little more than one-sixteenth of an inch in size, yellow at first but afterward becoming marked with black and red. They hatch from the eggs in May and immediately commence sucking the juice of the leaves. The secretion of honey-dew is so copious that the insects soon become surrounded by small puddles of this sticky liquid, in which they sit and grow. In about a month, they change to the adult, winged form (Fig. 59), in which stage they are provided with wings, and with strong jumping legs. When disturbed, they jump and fly away, sometimes being so numerous as to appear to fly in droves. Several broods are reared in one season.

REMEDIES.

Spray with weak kerosene-emulsion (Professor Slingerland recommends the emulsion given in our chapter on insecticides, diluted as much as 25 times),

while the insects are in the immature condition in late May and early June. At this time they cannot fly.

Any of the strong winter washes should prove all right as they pass the winter hidden away in cracks and crannies and under the buds. Clean culture will also prove useful for, judging from allied species, many adults will be found to pass the winter in rubbish.

AFFECTING THE FOLIAGE.

The Pear-leaf Blister-mite. (*Phytoptus pyri.*)

About the time when the young pear leaves become full grown, and while they are still tender, they sometimes are disfigured by pinkish, thickened patches, involving a portion of the leaf, or occasionally the entire leaf. As the leaf becomes firmer in texture, the patches become darker, finally appearing black and corky. A thin slice through such a thickened, corky patch, shows, under the microscope, a cavity connecting with the outside by a small opening. In the cavity may sometimes be found the cause of the mischief; minute, white mites, elongate in form, and so small that a glass is required in order to be sure of them. These little mites are the cause of the thickened growth or gall, and the consequent injury to the foliage. Sometimes they form galls in the young fruit as well. Often times the foliage falls, and the fruit fails to amount to anything. The mites pass the winter tucked away under the bud scales.

REMEDIES.

As the mites are concealed, during the growing season, in the galls of the leaves, it is useless to spray during that period. In the winter, however, they may be killed by a spray of strong kerosene-emulsion applied while the buds are dormant, or at any rate before they open in the spring.

The Pear Slug. (*Eriocampoides Limacina.*)

Just before the time that cherries ripen, one is likely to find the foliage eaten, or rather skeletonized on the upper side, so that only the larger veins remain. A closer search reveals sticky, slug-like larvæ about half an inch long, dark, dirty green in color and shaped like small clubs, broad just behind the head but tapering to a slender tail. There is sometimes a later brood in August, but the first brood does the most damage. These disgusting little slugs work on cherry, plum and quince. The egg is laid on the under side of the leaf, under the epidermis or skin. This is done quite early in the season but the larvæ usually escape detection until they are well grown. When full grown, these little "slugs" burrow

Fig. 60.—Pear slug from Saunders. Insects Injurious to Fruits.

into the soil and make little cells in which they pass the pupal stage, emerging, after a time, as black, four-winged insects resembling flies, but really belonging to the order of wasps. Each is provided with a small saw-like apparatus under the abdomen for the purpose of sawing a little pocket in the leaf in which to deposit an egg. Hence the name of saw-fly is applied to the insects of this class. This insect often causes a large part of the foliage to fall prematurely.

REMEDIES.

None of our fruit insects are easier to control than the pear and cherry slug. Dry-slaked lime will kill many of them if merely dusted on, the sticky surface of the slug causing the dust to adhere in such quantities as to cause death. Hellebore applied either dry or steeped in water will kill them. The arsenites are

effective but should not be used on the first brood because of the danger of poisoning the fruit. Even road-dust has been used effectively, although almost anything else is more effective.

AFFECTING THE FOLIAGE.

White-marked Tussock-moth (see Insects affecting the apple).
Fall Web-worm (see Insects affecting the apple).
Bud-moth (see Insects affecting the apple).
Aphids (use same remedies as for apple aphids).

AFFECTING THE FRUIT.

Bumble Flower-beetle (see Insects affecting the peach).
Codling-moth (see Insects affecting the apple).
Plum Curculio (see Insects affecting the plum).

INSECTS AFFECTING THE PLUM.

AFFECTING THE ROOTS.

Peach-tree Borer (see Insects affecting the peach).

AFFECTING THE TRUNK.

Flat-headed Apple-tree Borer (see Insects affecting the apple).

AFFECTING THE BARK.

The European Fruit-scale. (*Aspidiotus ostreaeformis.*)

Next to the San Jose scale in point of importance, comes the European fruit-scale, and while no such far-reaching destruction can be charged against it as against the San Jose scale, it is a serious pest worthy of careful consideration. There are points of difference between this scale, the eccentric scale, and the

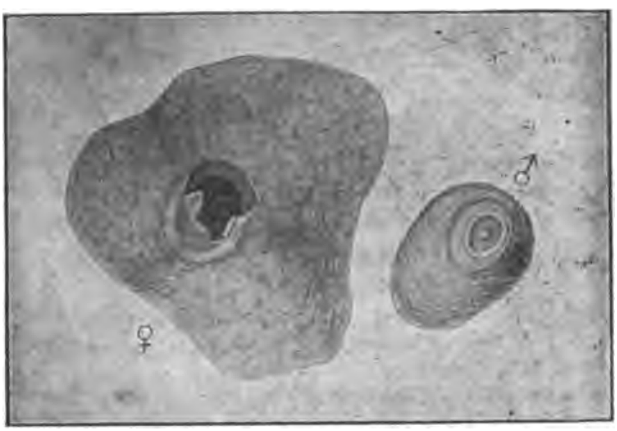

Fig. 61.—European Fruit Scale, enlarged. Author's illustration

English walnut scale, but they are so slight that it seems hardly worth while to try to distinguish them in a work of this sort. There are indeed points of difference between the insects beneath the scales but they require a microscope for elucidation. The eccentric scale does, however, possess one character that will often render it possible to make a good guess as to its identity without the aid

of a microscope, the cast skins of the eccentric scales being to one side of the center while the cast skins are nearer the center in the case of the fruit scale and the English Walnut scale. The European fruit scale produces several broods of young in a year and the young are born alive. They multiply quite rapidly, but seldom produce the crust on the bark which is to be found with the San Jose scale. They seem to prefer plum to all other trees, but work also on apple, pear, currant, cherry, silver maple and a number of other trees and plants. They do not work so disastrously as does the San Jose scale but often kill their host plants, especially if they be plums or currants. Fortunately this pest does not attack the peach.

Fig. 62.—European Fruit Scale on plum. Author's illustration.

REMEDIES.

The same remedies that are recommended against the San Jose scale will prove effective here. For a more extended account of this pest see Bul. No. 180 of this station.

The Apricot Scale on Plum. (*Lecanium armeniacum.*)

Occasional outbreaks of this scale have occurred in Michigan. Unlike the San Jose scale and its allies, the apricot scale is large, and soft until full grown, the full sized females measuring from one-eighth to three-sixteenth of an inch in length. The eggs are laid inside the skin or shell of the mother. They hatch during late June or July. At first the young lice wander about but after a time they settle on the under sides of the leaves, remaining until late August, when they migrate to the twigs, settle down, and thereafter move but little. The males, like the males of other scale insects, are winged. Each develops under a waxen skin of oblong form. Fig. 63 shows a number of females enlarged four and a half times. They are yellowish brown in color, marked with black, and are covered with a powdery material which resembles the bloom of some fruits. They are soft until full grown, after which the skin becomes a hardened shell of horny

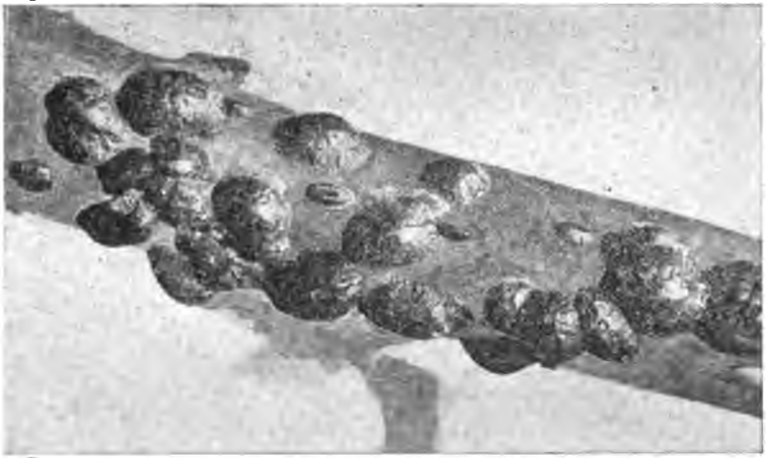

Fig. 63.—Apricot Scale, on plum, enlarged four and one-half times. Author's illustration.

material in which the eggs are deposited The winter is passed while they are still soft and but partially grown. This fact gives us one method of controlling them. The pest works also on grape and cherry besides several other plants.

REMEDIES.

Take advantage of the soft and unprotected condition of the creature during the winter and apply one of the strong winter sprays recommended for the San Jose scale, either lime-salt and sulphur prepared in the ordinary way, or kerosene-emulsion in which the water forms about one-fifth of the liquid when ready to be applied.

AFFECTING THE FOLIAGE.

Plum Aphids. (*Phorodon humili, Ophis pruni* et al.)

Several species of plant-lice infest the plum, the two most important being the true plum-louse (*A Pruni*), which remains on the plum all the year round; and the hop-louse (*P. humuli*). This latter species is restricted to regions where hops are grown, as a matter of course, and migrates, back and forth between the two host plants, spending the summer and early fall on hops, and late fall, winter and spring on cultivated or wild plum. In other words the eggs are laid on the plum branches in October to hatch out the following spring. The young lice which are at this stage provided with wings, migrate to the hop yards for the summer, their progeny coming back to winter quarters in the fall. The true plum-louse remains the year round on the plum trees, curling the leaves and sometimes doing considerable damage.

REMEDIES.

The ordinary spray of kerosene-emulsion, or tobacco-water, will kill the lice easily enough if they can be reached. Very thorough work in the central part of the tree is required to hit them because of the curled condition of the leaves.

The Plum-tree Sphinx. (*Sphinx drupiferarum.*)

The hawk-moths seldom occur in sufficient numbers to seriously affect our fruit trees. Occasionally the plum foliage is attacked by large, green caterpillars, each having a curved horn or spike projecting from the caudal end and with the body marked by seven short diagonal stripes of purple on each side, each stripe being bordered beneath with a narrow stripe of white. These are the larvæ of the plum-tree sphinx. When full grown, they burrow into the ground and

change to pupæ, the adult moth emerging during the following June. The adult is one of the large hawk-moths or humming-bird moths that visit our flower gardens during the evening, to sip nectar from the flowers. They are large, strong-flying moths, measuring between three and four inches from tip to tip of the extended wings. The moths are grey and dark brown in color. The eggs are said to be laid singly on the foliage of the plum.

REMEDIES.

As these larvæ are large, conspicuous and are scattered here and there over the orchard, it does not pay to try to poison them. The cheapest and most effective measure is to destroy them by hand whenever their work becomes evident.

AFFECTING THE FOLIAGE.

Tent-caterpillar (see Insects affecting the apple).
Canker-worms (see Insects affecting the apple).
Fall Web-worms (see Insects affecting the apple).
Bud-moth (see Insects affecting the apple).
Rose Chafer (see Insects affecting the grape).

AFFECTING THE FRUIT.

The Plum Curculio. (*Conotrachelus nenuphar.*)

The little Turk or plum curculio needs merely to be mentioned to recall unpleasant recollections to the plum, peach and apple raiser wherever the pest abounds.

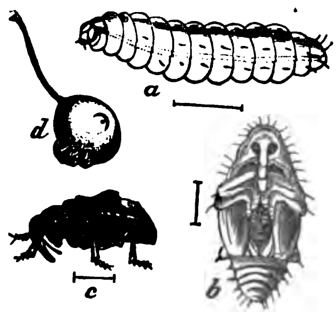

Fig. 64.—The Plum Curculio, from Riley, First Annual Rep. of State Entomologist of Mo.

But one brood is raised each year, the beetle passing the winter in the adult condition hidden away in rubbish, etc. In the early spring, they commence feeding on the swelling buds. When the fruit is set, they lay their eggs therein, first making a small hole in the side of the plum. After thrusting in an egg the beetle carefully cuts a lunate or semicircular flap into the flesh with the egg at the base of the flap. This is done to prevent the too rapid growth of the plum from crushing the egg. The characteristic half-moon-shaped mark of the curculio is found also on peach, pear, apple and cherry, besides some other fruits. The cherry grub, as the plum curculio is called when found in cherry, develops just as in the case of the plum, but in the other cases the result is merely to deform the fruit. The young larva works in the flesh of the plum, causing it to fall early to the ground. The grub passes into the soil and changes to a pupa, afterward becoming an adult and hiding away in autumn for the winter.

REMEDIES.

Early in the morning and late in the evening, the beetles are more or less stupid and are easily jarred from their hold on the tree to sheets, or cloth covered frames. They feign death (play possum) when jarred. In order to capture them, make a large frame of light wood and stretch cloth over it with a slot opening to the middle, place this under the tree, so that the trunk of the tree comes in the center of the frame; now strike quick sharp blows on the larger limbs

with a padded maul having a handle six to eight feet long. A long handled maul makes it possible to reach up into the tree. The beetles will fall to the sheet or frame and can be gathered up and dropped into kerosene. This should be done about the period of blossoming to obtain the best results.

Spray with paris-green, using one pound of poison, and one pound of lime, to 175 gallons of water (see chapter on insecticides). Do this just as the buds swell and repeat immediately after the blossoms have fallen. If the beetles remain plentiful, spray once more after about two weeks.

The Plum Gouger. (*Coccotorus prunicida.*)

The gouger is a small snout-beetle, about a quarter of an inch long. Its method of work is much like that of the curculio. It is mottled brown in color, with short whiteish hairs that give it a pruinose appearance. It can be easily distinguished from the curculio by its size and by the absence of humps on the wing-covers. It confines its work for the most part to the Mississippi valley and the West.

Fig. 65.

Figs. 65 and [66.—Plum gouger showing beetles, enlarged, and pits from which gougers have emerged. Author's illustration.

The adult beetle hibernates in the winter, and in the spring attacks the flowers of the plum in a manner at once peculiar and ingenious. The part eaten is the ovule or the part which would, if uninjured, in time become a fruit. The gouger eats a hole in the side of the calyx, the green cup at the base of the flower, and reaching in with its long beak eats the coveted part. Later the gouger eats holes in the young fruit, sometimes laying eggs therein. The egg is laid in a hole in the fruit with no crescentric flap as in the case of the curculio. The young grub works directly into the soft pit, and lives there, leaving no indication of its presence, except perhaps a scar on the outside of the fruit and the gum which exudes from it. Sometimes, however, a malformation of the fruit results. Here in the pit, the pupal stage is passed, and during the latter part of August, the adult beetle emerges. The fruit usually does not fall until just previous to the exit of the inhabitant.

REMEDIES.

During the period of bloom and just before and after this period, the beetles may be obtained by jarring, just as is done for the curculio. Jarring should

Fig. 66.

be kept up just as long as the beetles are obtained, for one little beetle obtained early in the season amounts to a good deal. It must be borne in mind that the gouger does not thin the fruit as does the curculio, but that the gouged fruit remains until late, drawing on the strength of the tree about as much as a perfect plum.

As most of the fruit falls before the beetles make their exit, immediate destruction of fallen fruit will make away with many beetles. Hogs accomplish this very nicely but if hogs are objectionable, pick up the fruit by hand and bury it just as soon as it falls. The arsenites do not seem to prove as beneficial as we could wish, but no doubt they will pay for the application. Prof. C. P. Gillett of Colorado, recommends the hand picking of all gouged fruit. This combines the benefits obtained by thinning, with those resulting from the death of the insect.

INSECTS AFFECTING THE STRAWBERRY.

AFFECTING THE ROOTS.

The Strawberry Root-borer. (*Typophorus canellus.*)

A beetle that works on the strawberry plants, both in the larval and in the adult stages, is the strawberry root-borer. The larva of this beetle has the appearance of a minute white grub about one-eighth of an inch long, white with a reddish-brown head. It feeds on the roots, changing to the pupal condition, in a small oval cell, made by turning round and round in the soil.

The full grown beetles appear here in great numbers during the first part of May. They are about one-eighth of an inch long, stout, highly polished, usually brown, with four blackish spots on the back. The color, however, is variable, sometimes being quite dark. The beetles pass the winter hibernating in rubbish, coming out when the weather becomes warm, and laying the eggs for the brood that reaches the adult stage in July. At this time the adults feed on the leaves, and if numerous attract attention. The July brood feeds during the rest of the summer on the foliage and then hibernates, coming forth the following spring to repeat the process. There are several closely allied species of beetles which differ in the dates of their emergence and which pass the winter somewhat differently.

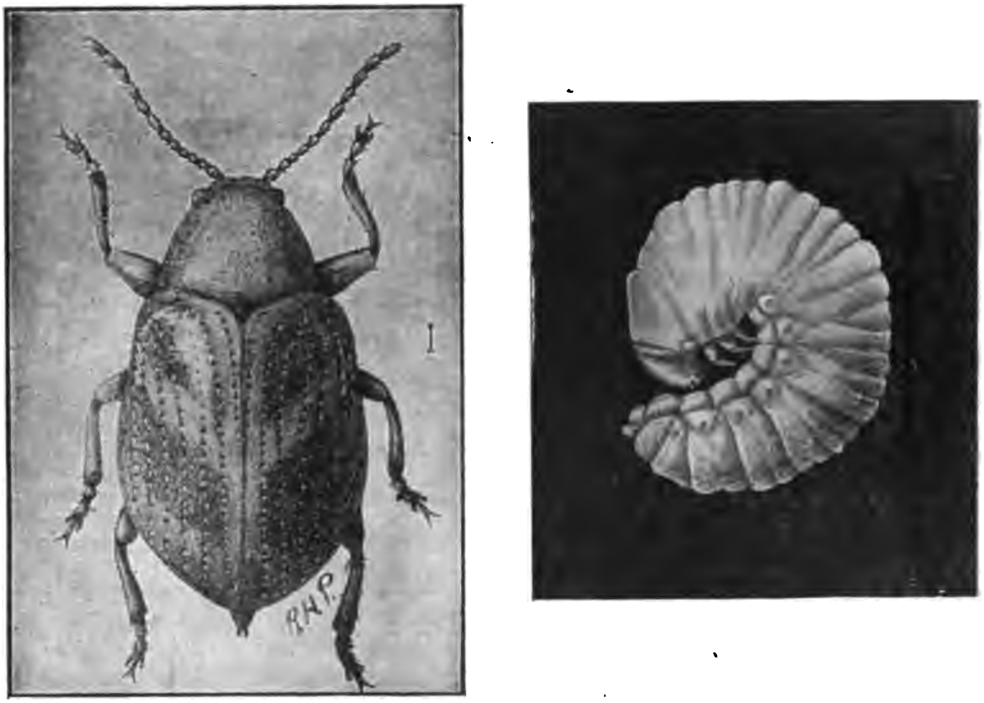

Fig. 67.—Strawberry Root-borer, adult and larva, enlarged. Author's illustration.

REMEDIES.

Whenever the adult beetles are present, and the plants are not in bloom, no sets or fruits being present, they may be destroyed by a spray of paris-green, applied at the rate of three or four ounces to forty gallons of water or bordeaux. When the fruit is set, but small, hellebore may be used.

The writer has not had an opportunity to use commercial fertilizers, but they should prove useful, as should wood-ashes when used in sufficient quantity. Never set a new field near an infested field, nor re-set a piece of land inside of several years after an infestation.

June-beetles. (*Lachnosterna* spp.)

June-bugs, May-beetles, dor-bugs, etc., etc., are familiar to all of us; large brown or yellowish beetles that are strongly attracted to light, and which often fly about the rooms on summer nights, bumping their heads against the lights, and creating disturbances. They go by various names, but create as much trouble under one name as under another. They feed, in the adult stage, on various trees and shrubs.

The egg is said to be laid in grass land in early June. The grubs being the common white grubs which feed on all sorts of vegetation. When numerous enough, these creatures sometimes devour the roots of grass so completely that the sod may be rolled up like a carpet. They also work sad havoc among a variety of plants and trees, notably on strawberries. They require two years to develop, the pupal stage being passed in cells in the ground.

Many parasites prey on these beetles, and several diseases attack them. The writer has seen, what is probably a bacterial disease working among them and carrying them off by the million. It attacks the region near the bases of the

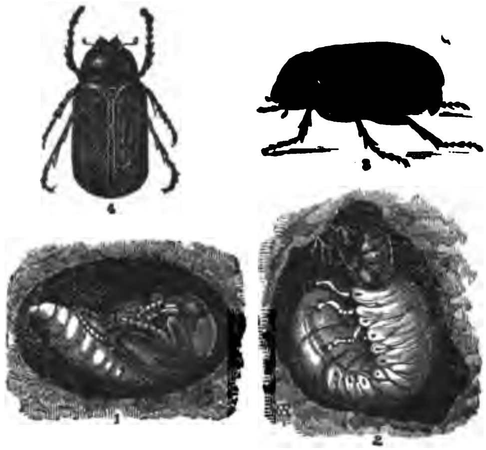

Fig. 68.—June-beetles, from Riley, Rep. State entomologist of Missouri.

legs, causing a black decay which spreads over the entire body. Poultry feed on them when given the chance, and many birds are fond of them, notably the crow. These and other diseases and parasites explain the sudden disappearance of the grubs on certain occasions.

REMEDIES.

Late fall plowing breaks up many of the pupal cells and exposes the larvæ and pupæ to their enemies. As they breed largely in sod land, it is well to avoid following sod or grass land with strawberries or with any fruit that especially suffers from their depredations.

AFFECTING THE FOLIAGE.

Strawberry Saw-fly. (*Harpiphorus maculatus.*)

An acquaintance of long standing is the strawberry saw-fly. The "worm" or false-caterpillar that does the damage, is a yellow or greenish, naked caterpillar not quite three-fourths of an inch long. Its yellow head has three or more brown spots, one above and usually one on each side, these spots being often more or

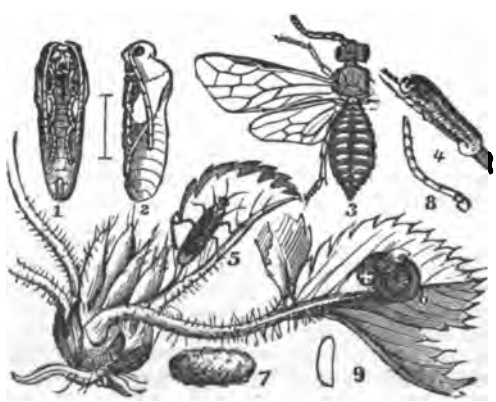

Fig. 69.—Strawberry Saw-fly. *Harpiphorus maculatus*, from Riley, Ninth Rep. State Entomologist of Mo.

less blended. There are twenty-two legs; six true, jointed legs, and sixteen false legs, distinguishing this larva from the caterpillars of moths, none of which living on strawberry have so many.

Early in June, the eggs are laid in small slits in the leaf stems. The young descend into the ground as soon as full grown, and spin frail cocoons, change to pupæ, and emerge as adults about the last of July or the first of August. In the case of the second brood, the process is repeated, up to the spinning of the cocoon, before cold weater sets in.

There is another species of saw-fly (*Monostegia ignota*), that closely resembles the species in question, but the heads of the larvæ lack the brown spots already described. The two species, however, are so alike in habits that the same treatment will apply to both.

REMEDIES.

When the fruit is set and only partially grown, use hellebore. It is likely that dry-slaked lime sifted on the worms, will kill them as it is effectual against many of its close relatives. The skin of the larva being sticky and tender, the lime clings to it and acts as a caustic.

After the fruit is gone, use paris-green or one of the arsenites.

The Strawberry Leaf-roller. (*Phoxopteris comptana.*)

The following is taken from the author's bulletin 175 of this station. "As the name implies, the leaf-roller is to be found in the curled foliage. The caterpillars are small, yellowish or greenish "worms" which feed on the leaves and cause them to curl up tightly into little clumps, which are bound together with silken webs. Often the enclosed spaces are lined with the same material making nests. The caterpillars or larvæ may be found by pulling apart the nests; when full-grown they are about three-fourths of an inch in length, slender and gently tapering. The adult, winged form, not seen so often, is a very small and delicate moth, reddish-brown and dusky in color, with black and white markings and about one-fourth of an inch in length, while the extended wings measure a little less than half an inch.

Fig. 70.—Strawberry Leaf-roller, enlarged. Author's illustration.

This dainty little moth comes forth early in the spring and lays its eggs for the first brood on the young strawberry leaves. These eggs hatch and the "worms" or caterpillars appear in June. If numerous, they devastate the strawberry beds and then, becoming adults, lay more eggs in September. These eggs hatch and the young "worms" have just about time enough to become full-grown and go into the ground for the winter.

REMEDIES.

After the first year of course no poison should be used on the plants before the berries are gathered, but directly after gathering the berries, or during the first year before the plants bear, the plants should be cut off close with a mowing machine and burned. The field may then be sprayed with paris-green and lime, which will serve to kill numbers of the full-grown worms in the leaves and also to poison what young larvæ may come from the eggs already laid. The spray, of course, should be repeated as long as any caterpillars remain. This method should prove of great benefit and the regular rotation of crops will also be found useful. In some instances the fields have been burned over, with good

results, instead of cutting with a machine. This was done about the time that the second brood of worms appeared.

The worms are easily killed with a spray of paris-green and lime, but as this must not be used before the fruit is harvested, hellebore may be used early in the season before the fruit is of much size.

After the crop is harvested the plants should be mowed and treated with paris-green as previously advised to guard against the appearance of the pest next season.

DIRECTIONS FOR PREPARING INSECTICIDES.

Most insects may be classified either as chewing insects or as sucking insects. Beetles, grasshoppers, etc., chew their food, while bugs, suck theirs by means of long piercing beaks with which they penetrate inside to the juicy parts of the plants. Moths and butterflies suck their food, when in the adult condition, but chew it when in the larval state. Now chewing insects, in many cases, eat foliage, fruit, etc., and if this food be treated with a coating of some arsenical poison, they get the poison in the ordinary course of events, and die. Many chewing insects, like some of the borers, are protected in their burrows and never eat at the surface of the plant except possibly, when just entering the plant.

Sucking insects are not affected by poisons of this nature, as they draw their supply of food from beneath the surface. With them it is necessary to use some substance like kerosene-emulsion, which kills by contact, but does not injure the plant. Special contact insecticides have been found to work well against special insects and at certain definite times, therefore the best results are obtained by using a variety of killing agents, each suited to a particular purpose.

While it is necessary to spray evenly and thoroughly with an arsenical poison, like paris-green, it is easily seen that the utmost care is required to obtain good results with a contact insecticide. Most beetles and caterpillars wander about more or less and some of them will find the poison themselves, on the other hand, each insect must be hit by a contact insecticide to be killed.

As everyone knows, the arsenical poisons are the cheapest when effective, and when nothing prohibits their use. Fruit well advanced or that which ripens quickly, should not be sprayed with permanent poisons like paris-green. Hellebore has the advantage of losing its strength after a time, and may sometimes be used when paris-green would not do. Then too, there is a very just law against applying any spray during the time of bloom, thus protecting the little insects of the bee family from being killed off. These little fellows fertilize the flowers and make it possible for the fruit to obtain a start.

Now a word about applying the spray. In general use a nozzle that will produce a fine spray, one that will stick in minute particles to the plant and which will not go on in drops. Always stop spraying before the tree commences to drip. Paris-green, and all the arsenites, remain in suspension in the water if properly prepared, and are not dissolved. These small particles of poison will settle to the lowest part of a drop of water, and remain on the plant as the water evaporates, if the drop be of small size. If, on the other hand, the drops are large enough or numerous enough to run together and drip off, most of the poison drips off first, leaving very little to dry down on the plant. It is therefore desirable to have the water evaporate as quickly as possible. This is best brought about in dry, sunshiny weather. Such weather is best for kerosene-emulsion also, because the oil is apt to injure the foliage if left on too long before evaporating. Therefore choose dry, sunshiny weather for spraying if possible.

FUNGOUS DISEASES OF FRUITS IN MICHIGAN.

BY B. O. LONGYEAR.

[Special Bulletin No. 25.]

The necessity of systematically combating the diseases which affect the orchard and its product is so generally recognized at the present time by the progressive fruit grower, that it seems scarcely necessary to urge the importance of this matter in his case. In fact the spraying and other treatment of his trees by the professional fruit grower forms a regular part of each season's work, and any information which leads to a clear understanding of the agencies of disease is sure to be appreciated by such a person as enabling its possessor to do this work more intelligently, therefore more successfully. In spite of the vast amount of information along this line which has been published during recent years there is still a considerable lack of knowledge of the true nature of the common diseases to which orchard fruits are subject. Thus the general farmer who grows fruit as one of several products is too often without a proper understanding of these matters, consequently his trees are usually allowed to take care of themselves. The result is very evident in the diseases which appear. The leaves, the organs of respiration and assimilation, become spotted and unhealthy or perhaps shrivel and fall off; the branches die back; the trunks are scarred, cankered and decayed; and the fruit while dimished in quantity is often of so poor a quality as to seriously injure its market vaule and keeping qualities. The serious losses in the case of barreled apples which were badly affected with scab has led the apple buyers in some portions of the state to refuse the fruit from orchards which have not been properly sprayed and tended. Thus in such instances the loss consists not merely in the diminished crop of poor quality but also in the absence of a market for the fruit.

While a great deal of information relating to plant diseases and their treatment has been printed in bulletins and agricultural papers it is so scattered that the majority of persons engaged in fruit growing in this state doubtless find it somewhat tedious to find this information when wanted on short notice. Consequently this bulletin is intended to serve as a sort of text book of the diseases most common and destructive to fruits in Michigan. Technicality has been avoided as much as possible, the attempt being made to give clear and readily comprehended descriptions of each disease together with the most approved methods of treatment. The information has been gathered wherever the most satisfactory accounts of diseases and their treatment could be obtained. The publications of the U. S. Department of Agriculture and the bulletins of the various State Experiment Stations have furnished the greater part of this matter. This bulletin, however, is not a mere compilation. Most of the figures are from original dawings and photographs and represent actual specimens studied by the author. Also personal observations of the principal diseases and the more common methods of treatment have been made.

COMMON CAUSES OF PLANT DISEASES.

Plants may be diseased in several ways. In fact the condition brought about by anything which disturbs or prevents the carrying on of the normal functions of a plant or any of its organs may, in a general way, be considered a disease. The most common diseases of plants are now known to be due to the attacks of parasitic organisms such as bacteria and fungi. Fungi, however, constitute the commonest of the causes of diseased conditions in plants.

Fungi themselves are plants of a very low order and are quite simple in structure as compared with plants which bear leaves and flowers. Most of the flowering plants possess leaves which contain a green coloring matter

(Chlorophyll) which enables them in the presence of sunlight to assimilate the raw food materials of the soil and air and thus to grow. Fungi, however, do not possess this green coloring matter, hence are forced to depend on organic substances such as rotting leaves, wood, straw, manure, and the humus of the soil (Saprophytic Fungi) or on the tissues of living plants (Parasitic Fungi). Familiar examples of the former are seen in the common mushrooms and the shelf or bracket-like fungi which grow on decaying stumps and logs. (Fig. 41.) These are mostly plants of considerable size some of them being valued for food. The fungi which exist at the expense of living plants, however, are mostly very small organisms and require the use of the microscope in studying them. They make up, however, in numbers and rapidity of growth for their insignificant size, consequently these parasitic fungi are able to cause incalculable injury to cultivated crops each season.

In its early stages of growth a fungus consists of a delicate mass of cobweb-like threads which branch in all directions in search of nourishment in very much the same manner as the fine rootlets of other plants. This network of slender threads is known as mycelium or spawn and serves the purpose of root and stem. It may be found at almost any time by overturning old boards or decaying leaves lying on the ground. In the case of the parasitic or disease producing fungi the mycelium invades the tissues of the plant on which it lives (known as the host plant) and causes in some cases swellings and distortions of the affected part, or in other cases the cells of the host plant are killed as soon as attacked, thus leading to the death of the diseased organs or of the entire plant. In some cases, however, the mycelium lives on the surface of its host merely sending little sucker-like branches into the affected part as in the powdery mildews.

SPORES.

Fungi are reproduced and spread by means of minute bodies called spores. Spores may be formed in a variety of ways after the mycelium becomes established. The most simple method is that in which the mycelium gives rise to branches which bear one or more spores at the apex or along the sides, or, in some cases, the branch itself becomes changed into a chain of spores by the formation of little partitions or septa, the cells thus formed finally separating from each other and each constituting a spore. More complex methods usually consist of the formation, by the mycelium, of fruiting bodies often dark in color, which are hollow and either give rise to spores from the inner surface directly or to small spore sacks (asci) each containing a number of spores which when mature are discharged by the breaking of the surrounding wall.

Spores are so small and light that they can readily float in the air for some time as an almost invisible dust and may also be carried on the bodies and feet of birds and insects. In some cases they are produced in such enormous numbers as to form a cloud of smoke-like dust when disturbed, as in the powdery masses of corn smut. Some idea of the amazing number of spores produced by such a fungus may be gained only by knowing their measurements. Thus a mass of such spores the size of an ordinary match head could contain about ten million of these microscopic bodies, enough to cover an acre and a half at the rate of one spore to the square inch.

When the spores of fungi are surrounded by favorable conditions of moisture and heat they may germinate usually by pushing out a slender germ tube. In the case of the parasitic fungi this germ tube enters the tissues of its host plant and forms the beginning of the mycelium. In this manner the host plant becomes infected. A great many fungi possess two forms of spores. One kind, known as summer spores, is produced in great abundance during the growing season. They are capable of germinating as soon as mature and thus serve to spread the disease from one plant to another. The other kind of spores, known as resting or winter spores, is formed usually late in the season and remains over winter in a dormant condition often in or attached to the dead tissues of the host plant. When spring arrives and the host plant is pushing out its first tender growth these resting spores germinate and thus start the disease anew.

In the case of some parasitic fungi the mycelium is perennial in the stems of the host plant remaining dormant during winter but becoming active again the next spring, as the leaf curl fungus of the peach and the black knot of the plum.

DISEASES OF THE APPLE.

APPLE SCAB.

(Venturia Pomi (Fr.) Wint.)

Fig. 1.—Apple leaves affected with the Apple scab fungus. (Original.)

This disease of the apple commonly known as "scab" or in some cases "black spot," is probably familiar to every grower of this fruit. It first appears in spring on the young foliage producing velvety, olive colored patches. This form is sometimes known as "mildew" or "leaf blight." In severe cases the leaves become shriveled and discolored, eventually falling off. The fungus also attacks the stems of the young apples at blossoming time, especially if the weather at this time is unusually cool and moist. This causes the young fruit to shrivel and drop off, often greatly reducing the crop of mature fruit.

The most characteristic effects of this fungus parasite, however, are found on the fruit itself. Here the spots at first appear much like those on the leaves but as the fruit develops the fungus works under the cuticle or outer layer of the skin causing it to scale off. These spots on mature apples have a dark brown or blackish color with a narrow border of a light gray color. The spots are usually most numerous around the blossom end of the fruit. On badly affected fruit the spots run together sometimes covering one-third of the surface. Deep cracks often occur in such cases which allow the apple to dry out.

Apple scab is without doubt the worst disease affecting this fruit. This is due not alone to its destruction of the foliage and young apples nor to the unsightly

spots which it causes on the mature fruit. In addition to all this it opens a way for the entrance of numerous rot-producing fungi into the tissues of the mature apple. Thus during the seasons of 1902 and 1903, which were characterized in this state by an unusual rainfall, great quantities of apples were lost soon after packing and in storage and even during shipment through the agency of these soft rots following apple scab. In some cases reported apples affected with scab began rotting while still attached to the trees, the loss in some cases amounting to four-fifths of the entire crop.

Fig. 2.—"Scab" spots on an apple. (Original.)

Among the fungi which produces soft rot of apples and which usually attack the fruit where scab exists, the following have been noted as most common in this state:

Cephalothecium roseum.
Penicillium glaucum.
Sclerotinia fructigena.
Mucor stolonifer.

PREVENTION AND TREATMENT.

The fungus of apple scab thrives during moist cool weather, consequently the disease is apt to be most prevalent during seasons when such weather prevails especially during the early part of summer. Fruit grown on closely crowded trees where air and light are shut out appears to be more severely affected than where the opposite conditions prevail. Therefore a location securing good ventilation, proper spacing of trees, and systematic pruning are to be considered as preventive measures in the case of this disease. It has been found that the fungus passes the winter on the fallen leaves, appearing as minute, black bodies buried in the leaf tissues. From these are given off in the following spring the first crop of spores which attack the lower leaves, the disease later spreading to all parts of the tree. Thus another prventive measure is suggested and recommended, viz.: the destroying of these dead leaves which serve as agents of infection. This may be done either by raking and burning them or by plowing them under in spring before the spores are shed.

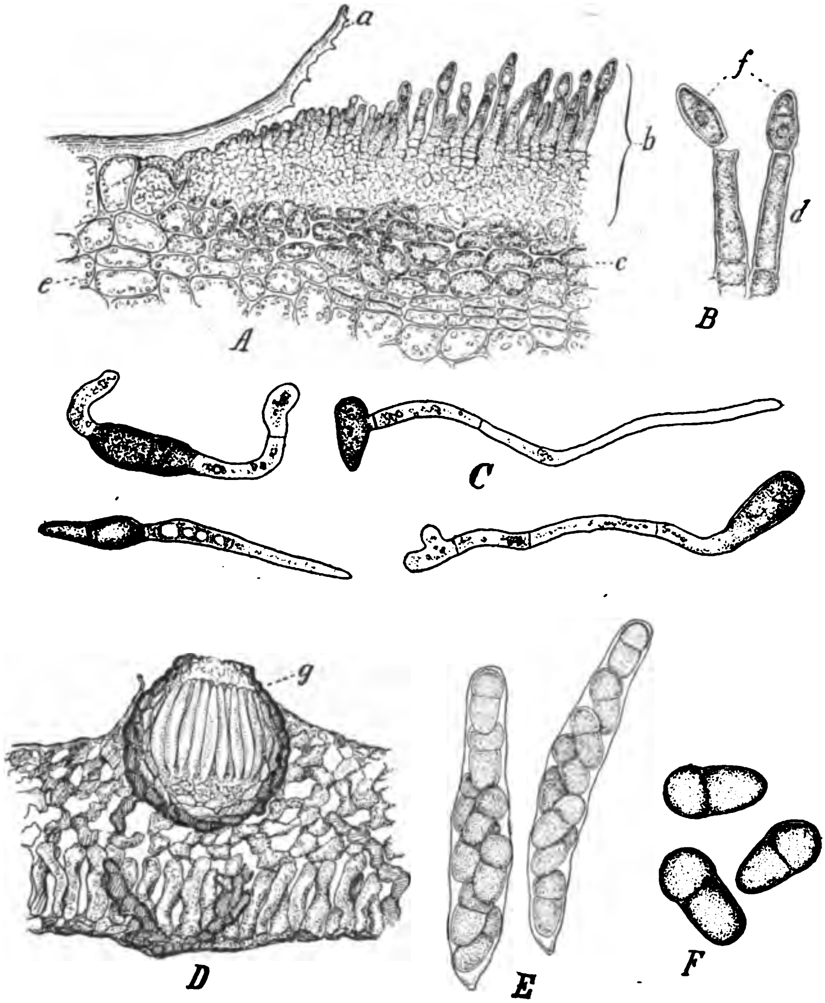

Fig. 3.—Microscopic structure of the scab fungus. A, portion of a section through a scab spot on an apple showing the fungus; (b), spreading under and lifting the cuticle, a; c, partly disorganized cells of the apple; e, healthy cells of the apple; B, two spore-bearing stalks (conidiophores), giving rise to summer spores (conidia), f; C, spores germinating; D, portion of a section through an affected leaf of apple which has lain on the ground over winter, and has given rise to the winter stage spore of the disease; g, spore case (perithecium), containing a bundle of spore sacs (asci); E, two spore sacs (asci), more highly magnified, each containing eight two-celled winter spores, three of which are shown at F. All highly magnified. (Original.)

The planting of varieties which are naturally less subject to the scab is also to be considered as a preventive measure. Spraying for the prevention and treatment of this disease has proven of unquestioned value and a paying investment to the apple grower. The first application made before the buds open may be the copper sulphate solution (*A*) which is cheaper and easier to prepare and use than Bordeaux mixture. By many growers this application is considered the most important one for fungous diseases and should not be neglected. At this time great care should be used, to avoid driving on the soil when full of water, especially if it contains much clay as it is apt to become puddled thereby and its texture much injured. After the leaves appear, however, it will be necessary to

use Bordeaux mixture, the first application of this spray to be used just before blossoming. This is the most important treatment of the season. The second after the blossoms fall and two or three other applications at intervals of ten days to two weeks will prove beneficial, especially if the season is a wet one. The final spray may consist of the weak solution of copper sulphate B to avoid staining the fruit.

BITTER ROT, RIPE ROT, ANTHRACNOSE.

(Glomerella rufomaculans Von Schrank & Spalding.)

Fig. 4.—An apple decaying with the bitter rot fungus, the affected portion showing pinkish spore pustules.

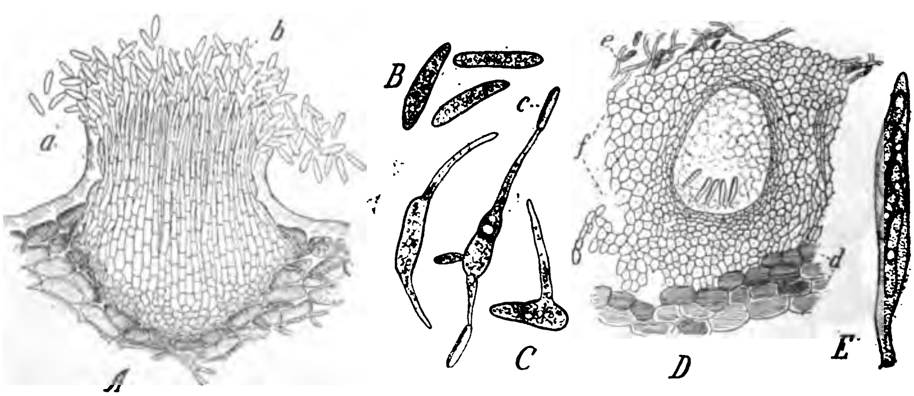

Fig. 5.—Microscopic structure of the bitter rot fungus. A, section through the affected part of an apple. The mycelium of the fungus has formed a mass of spore bearing stalks (conidiophores) which have ruptured the epidermis of the fruit, and formed a pustule from which numerous summer spores (conidia) are being given off; A, cuticle of apple; b, spores; B, spores (conidia) more highly magnified; C, spores germinating in water. Two of them have become divided (septate), and one has formed secondary spores, c, on the germ tubes; D, section of an old affected apple, showing the permanent winter stage of the fungus; d, cells of the apple on which is seated the thick walled spore case (perithecium), f, in which young spore sacs (asci), are forming; e, mycelial threads among which are scattered some two celled spores (conidia); E, a mature spore sac, (ascus), containing eight spores (ascospores). All highly magnified. (D, E, after Burrill, the others original.)

Like the black rot the bitter rot is most prominent on the fruit. Infected apples show brown spots which rapidly enlarge until the whole fruit is involved. Small pimples soon appear in concentric order around the points of infection. From these pustules the spores ooze out, showing a pinkish color in mass, and are washed on to other apples by rain, or becoming dry, may be carried away on currents of air. A resting-spore stage is also known to occur on apples which have rotted with this disease, and this is one means by which it is carried through the winter. An investigation of the disease of bitter rot conducted by Von Schrank and Spalding in 1901 and 1902 revealed the fact that the chief source of infection arises from a permanent or winter stage of the disease in the form of cankers on the limbs of the apple tree.

Apples affected with this disease commonly possess a bitter taste although this is not always the case.

Bitter rot is very destructive in some of the more southern states, being especially bad in Southern Illinois, where it is the chief apple rot. Its presence in Michigan has been noticed as somewhat uncommon. The writer has found it on Pennock's red stored in a cellar and on packed Greenings. Ben Davis and Grimes' Golden are recorded as varieties most subject to this disease in Illinois. This fungus also occurs on the grape, pear, peach, quince and even on tomatoes.

The preventive measures and other treatment for this disease are practically the same as for the black rot fungus. Destruction of old diseased fruit and the removal of cankered limbs wherever found are to be practiced. Spraying to be successful should be begun before the disease appears.

BLACK BOT.

(Sphaeropsis malorum Berk.)

Fig. 6.—An apple affected with the black rot fungus, showing the wrinkled condition and dark color of the dry fruit which is often found hanging on the trees, or lying on the ground over winter.

Black rot is a common disease, especially on fruit of summer and fall varieties of apples. These are attacked usually when nearly mature and ofen while still hanging on the tree. Apples affected with this disease decay rapidly, becoming brown at first, with blackish discolorations under the skin. As the disease progresses the black color spreads until the fruit may become entirely blackened. The apples retain their firmness for some time, and then gradually dry out, be-

a b

Fig. 7.—Two young trees showing cankers due to the black rot fungus, and produced by artificial inoculation by Paddock.—a, pear; b, apple. (Original.)

coming much wrinkled and shrunken. Just under the skin of such apples small black dots or pustules may be seen even with the unaided eye. They are the spore producing bodies of the fungus. A section through one of these bodies (Fig. 8) shows it to be hollow with a projecting mouth from which the oval or egg-shaped spores escape. This fungus, however, is not confined to the fruit alone. In 1899 Paddock at Geneva, N. Y., demonstrated that it is the cause of a canker on the branches of the trees. Previous to that time these injuries were ascribed to sun scald but it is now definitely known that the black rot fungus is the true cause. Its first effect on the branches, which are attacked in the spring, is shown by a discolored area of the bark. These areas gradually enlarge killing the inner bark and later showing a definite boundary at the margin of the dead portion. Spore producing bodies form in these diseased areas. In time the bark becomes loose and rough or sloughs off exposing the bare wood. In severe cases limbs may be completely girdled when all that portion beyond the canker dies. The fungus apparently gains an entrance through cracks or wounds and seems to prefer large branches, although it also occurs on twigs. For this reason and because of its obscurity this disease is capable of doing much injury to the trees before its presence is detected. The leaves are also affected by the black-rot fungus which causes the appearance of brownish spots and may lead to the premature shedding of the foliage.

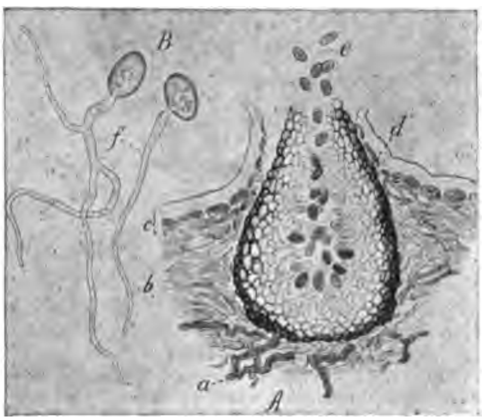

Fig. 8.—Microscopic structure of the black rot fungus. A, section from a wintered specimen of crab apple, showing, a, the dark colored mycelial threads among the cells of the fruit, b; d, a thick walled spore case (pycnidium), which has pushed through the epidermis, c, and is giving off dark colored spores, e, through the protruding mouth; B, mature spores germinating in water and giving rise to germ tubes, f. All highly magnified. (Original.)

TREATMENT.

Collecting and burning or burying the diseased fruit late in autumn will greatly diminish the number of spores of this fungus and consequently the liability of infection as the spores are given off from these affected apples. The spraying methods used for scab will also serve to check this disease. Cankers on large limbs should be scraped, painted with the copper sulphate solution A and coated with tar or paint. Smaller branches should be cut off below the cankered area and burned.

TWIG-BLIGHT, FIRE-BLIGHT.

(Bacillus amylovorus (Burr.) DeToni.) (See Pear.)

CANKER.

Canker is a general term applied to diseased areas in the bark and wood of the stem and branches of trees and causing more or less deepseated killing of the tissues. Such areas usually appear roughened by the scaling or cracking of

the bark or they may protrude in the form of knotted swellings. When the bark sloughs off the margins of the canker often show the attempt of the tree to heal the wound by the formation of a roll of new tissue. Several different fungi have been found to be the cause of cankers of the apple tree. They are mostly wound parasites. Experiment Station Bulletin No. 70, University of Illinois, 1902, discusses the principal fungi causing these cankers. (See also Black-Rot.)

Badly cankered limbs might better be entirely removed and burned than to attempt to save them. Cankers may often be healed by scraping or cutting away all diseased bark and wood and treating with sulphate of copper wash, and later coating with tar or paint. Spraying the trees as for scab will tend to prevent attacks from canker-producing fungi of the apple.

SOOTY BLOTCH.

This is of quite common appearance on the surface of apples which seem to have small patches of soot dusted on them. It is known to be of fungous origin and while not injurious, produces an unsightly effect. Among the varieties most effected are mentioned Greening, Northern Spy and Baldwin. It also attacks pears, especially Anjou and Lawrence. The Bordeaux spray successfully checks this fungus.

LEAF SPOT.

(Phyllosticta Pirina Sacc. & P. Limitata Pk.) (See Pear.)

POWDERY MILDEW.

(Podosphaera oxyacanthae (D. C.) D. Dy.)

This fungus lives on the surface of the leaves and sometimes causes trouble especially to seeding apples in the nursery. Prevented by spraying with Bordeaux.

RUST.

(Gymnosporangium Spp; roestelia stage.)

Rust effects the leaves causing yellowish spots in which are located the spore bearing organs of the parasite. The spores, which are of an orange color, attack the twigs of the red cedar, causing swellings, the so called cedar apples. Another spore form from these "cedar apples" infects the leaves of the apple causing the orange rust. This disease is quite injurious in some of the eastern and southern states but is not prevalent in this state. Paddock also reports a rust of the same nature on the quince in Colorado. Cutting the cedar trees which may be adjacent to affected orchards will tend to prevent this fungus from becoming troublesome.

FRUIT SPOT.

(Phyllacora pomigena (Schw.) Sacc.)

Fruit spot is not an uncommon trouble, especially on Baldwin apples. It appears in the form of small circular, slightly sunken spots of a brown color. This brown discoloration usually extends only a little way into the flesh of the fruit and possesses a bitter taste. For this reason it is often confounded with the bitter rot fungus. The disease spots give rise to spore producing pustules if the conditions are favorable. This disease has been greatly reduced by spraying as for scab.

PEAR DISEASES.

PEAR SCAB.

(Fusicladium pirinum (Lib.) Fckl.)

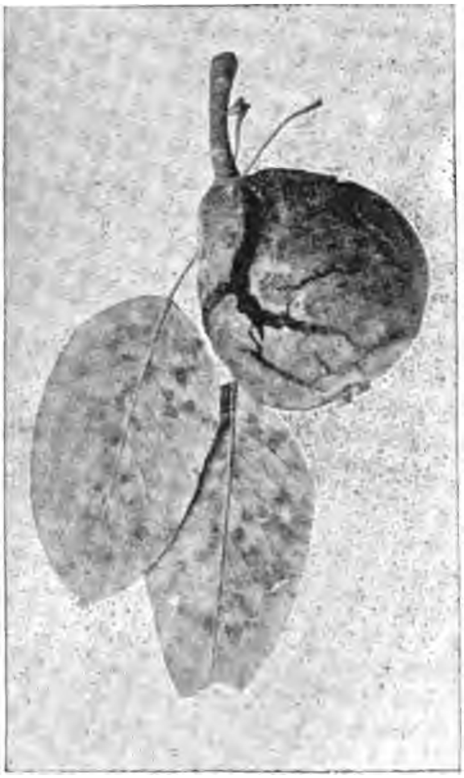

Fig. 9.

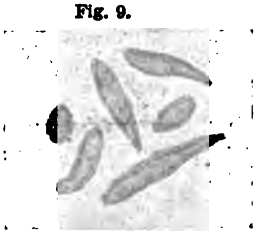

Fig. 11.

Fig. 10.

Fig. 9.—Fruit and leaves of Doyenne pear affected with pear affected with pear scab. (Original.)
Fig. 10.—One year old shoots of Flemish Beauty pear affected with the scab fungus. (Original.) Some of the spores taken from these branches eight months after they were cut germinated when placed in water.
Fig. 11.—Spores of the pear scab fungus highly magnified. (Original.)

Pear scab is so similar in appearance to the scab of apple as to hardly need other description. It attacks branches, foliage and especially the young fruit. In the latter case the pears soon fall off or if they mature are often worthless. Flemish Beauty seems especially subject to this disease as are also Seckel and Summer Doyenne. Young branches of the last variety sent to the writer, have presented a superficial appearance much resembling that of a scale insect. The outer bark on such stems rounds out in small, sharply defined swellings usually with a ruptured center. The presence of the spores of "scab" indicate the fungous nature of these spots.

The same line of treatment accorded to the apple scab is indicated for this disease. The planting of varieties less subject to the scab than the above mentioned kinds is also desirable.

LEAF BLIGHT.

(Entomosporium maculatum Lev.)

The fungus causing this disease attacks the leaves and fruit of the pear and quince. On the leaves it produces small rounded spots of a brownish-red color. On the fruit the spots soon lose their reddish color becoming much darker, while the surface sometimes becomes cracked in severe cases as with the scab. In the center of the diseased spots small pimples may be seen due to the formation of spores beneath the epidermis. Later these cracks open allowing the spores to escape.

The spores themselves are very peculiar, each being composed of two large and several small cells united and possessing several bristle-like processes giving them an appearance suggesting some kind of an insect.

So far as the writer has ascertained this disease is not so common in this state as those farther south and west. It is sometimes especially bad on nursery stock in the row.

It is quite readily controlled by the Bordeaux mixture, about three applications serving to keep the foliage and fruit free from the disease.

BLACK ROT. (See on Apple.)

This disease also sometimes appears on the pear and is capable of inducing a rot of the fruit as well as a canker on the branches.

LEAF SPOT.

(Septoria piricola Desm.)

This disease is of considerable importance in the pear orchard. It attacks the leaves producing numerous small dead spots of a greyish color. Under a hand lens these spots are seen to have a number of small black bodies buried in the tissue of the leaf and from these bodies issue the spores of the fungus. While each diseased area in the leaf blade may seem of little importance, yet their great number often causes the leaf to die and fall off. This early stripping of the foliage from the tree, often occurring in August, serves as a check to the further growth and the proper ripening of the buds and shoots. This untimely removal of the leaves may also cause the trees to push out another growth too late in the season to properly mature thus favoring winter killing and weakening of the tree.

TREATMENT.

Spraying with Bordeaux mixture has proven an effectual protection against this disease. About three sprayings are sufficient, the first just after the petals fall, the second and third at intervals of about two weeks.

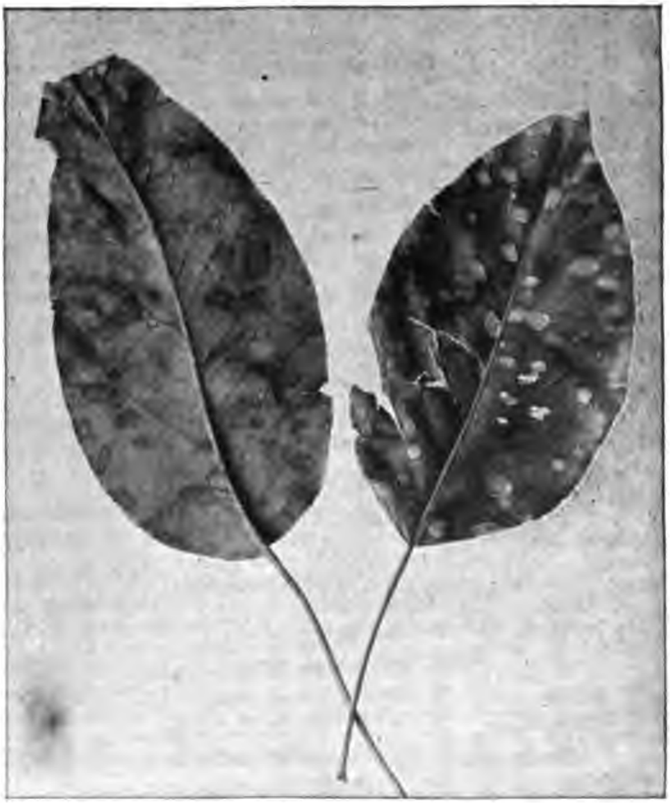

Fig. 12.—Pear leaves affected with the leaf spot fungus. (Original.)

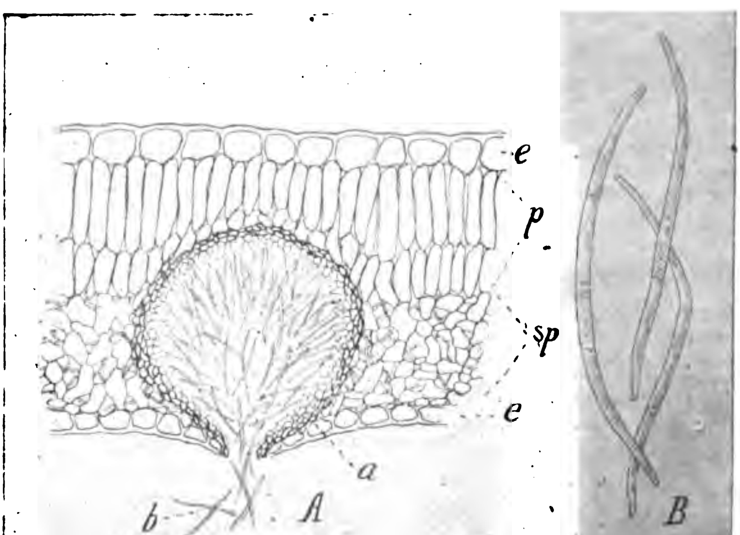

Fig. 13.—Microscopic structure of the leaf spot disease of pear. A, portion of a section through a leaf spot, showing e, e, epidermis of the leaf; p, palisade cells of leaf; sp, spongy parenchyma of leaf; a, a, spore case (pycnidium), giving out spores, b; B, spores highly magnified. (Original.)

PEAR-BLIGHT, FIRE-BLIGHT, TWIG-BLIGHT.

(Bacillus amylovorus Burrill.)

This disease is known to be of bacterial origin. It attacks the young, tender growth of apple, quince and pear and has also been recorded as attacking raspberry and blackberry shoots. Paddock, in a recent bulletin, describes a blight of apricots which also proves to be due to the same organism. Its worst effects, however, are seen on the pear. Its first appearance is indicated by the killing of the leaves at the ends of growing shoots, the leaves often presenting the appearance of having been scorched. The shoot is also affected and like the leaves may become blackened, the young wood and inner bark being much darkened. The disease progresses rapidly backward into the branches and in time may kill the entire tree. Small drops of a gummy liquid often ooze out of ruptures in the bark of the young affected shoots and this liquid contains myriads of the microscopic bacteria which are the cause of this blight. Bees and other insects often feed on this material and when they subsequently visit the flowers some of the germs of the disease may be deposited on the stigmas, thus introducing them into the tissues of the tree at these points. The bacteria also gain an entrance through wounds or insect punctures but are unable to enter the uninjured stems or leaves.

The rapid progress of the disease calls for immediate attention in order to prevent the great damage of which it is capable. So far no remedy has been found to prevent or cure the blight on an affected tree by means of spraying. The only effective measure seems to be the removal of the affected branches, cutting far enough below the limits of the disease to remove all the bacteria from the limb. Thus it is best to cut the branch off at least three or four inches below the lower limits of the disease, the removed branches being burned. This pruning should be done whenever the disease appears and a thorough removal of every affected branch during autumn is especially recommended, as the disease may otherwise pass the winter in the wood and appear the following spring. The fire-blight does not seem to prove as fatal to the apple tree as to the pear, in fact apple trees often outlive the attacks of this parasite. It is most destructive in the case of rapidly growing trees in which the wood is soft and watery, hence conditions which favor a slower and firmer growth tend to prevent or check the disease.

QUINCE DISEASES.

The quince which is closely related to the pear and the apple is also subject to some of the same diseases as those fruits.

FIRE-BLIGHT. (See on Pear.)

This disease is not uncommon on the quince and in severe cases kills nearly all of the new growth. The leaves become uniformly brown or black, this character distinguishing the disease from the leaf blight-fungus which causes spotting of the foliage. The same vigorous treatment is needed here as in the case of the pear, namely,—cutting off and burning all affected branches, care being taken to cut below the diseased portion.

LEAF-BLIGHT, FRUIT SPOT.

(Entomosporium maculatum Lev.) (See on Pear.)

This is the most common disease of a fungous nature which affects the quince. Its appearance on the leaves and fruit is similar to that on the pear. In severe cases it causes the premature falling of the foliage thus checking the normal development of the fruit.

Treatment is the same as for pear.

QUINCE RUST.

(Gymnosporangium aurantiaca Pk.)

The Quince Rust, also known as the orange rust of the quince, attacks the stems and young fruit causing swollen orange colored spots from which protrude small cylindrical processes. These tubular outgrowths are filled with dust-like

orange colored spores which are carried by the wind. Another form of this disease occurs on the red cedar like that of the orange rust on the apple. The spores given off by the "cedar apple" stage infect the quince while the yellow spores produced on the quince cause the formation of the swellings on the cedar, the so called cedar apples. Thus the disease is to be feared only where there are cedar trees near the quince orchard. Instances are recorded however in which the spores from the cedar apples have been carried a distance of eight miles.

Spraying with fungicides has been found only partially successful. The removal of nearby cedars is recommended especially if the brown knot-like swellings are found on their branches. All diseased quince fruits and cedar knots should be destroyed. Early spraying of both the quince and nearby cedars with Bordeaux mixture, if the latter are to be left standing, should be tried.

PALE ROT OF QUINCE.

(Phoma Cydoniae Sacc.)

The quince pale rot is distinguished by the formation of at first a pale spot which rapidly enlarges until the whole fruit becomes softened. The spots later assume a pale blue color while the skin wrinkles and becomes ruptured, the spores of the fungous disease being discharged from spore-cavities formed under the skin.

Spraying with Bordeaux mixture will serve to check this disease. All fruits which have rotted should be removed and burned.

BLACK ROT.

(Sphaeropsis malorum Pk.)

RIPE ROT, ANTHRACNOSE.

(Glomerella rufomaculans Von Schrank & Spalding.)

These diseases are both common to the apple and are described and treated under that head.

SOFT ROT, RIPE ROT, ROT OF FRUIT.

Soft rot is a general term often applied to some of those fungi which cause a decided softening of the fruit on which they work. There are a number of these fungous rots which affect apple, pear, quince, etc. They are mold-like plants which attack ripe fruit usually gaining an entrance into the fruit through wounds like those caused by the apple scab or by means of worm holes and other ruptures of the skin of the fruit, and also through the lenticles. They usually work rapidly soon changing the fruit into a soft juicy mass, more or less covered with the spore bearing tufts of the fungus. The spore production of some of these fungi is simply marvelous and it is largely due to this fact that these decaying fruits become a source of infection for the rest of the crop. These rots thrive especially in a moist, warm atmosphere and it is under such circumstances that they do the most harm. Cold, dry air, on the other hand, prevents the germination of the spores and thus retards the growth of the mycelium of these fungi and for this reason cold storage has been found to offer a valuable means of keeping fruit.

BLUE MOLD.

(Penicillium glaucum Link.)

This fungus is one of the most common of the molds which attack the apple and pear and is also often found on ripe grapes. It is distinguished by the bluish or greenish-blue powdery tufts which appear on affected fruit. These tufts give off spores in enormous numbers, a single one of which may be the cause of an infection. It is perhaps the most common cause of the rotting of apples stored in the cellar.

Fruit Mold (*Mucor Stolonifer Ehrenb.*), Fig. 16, B. is less common than the above but is frequently seen on apples, pears and a variety of substances of organic nature. It forms many dark colored threads which bear at the apex small blackish spore cases of a spherical shape.

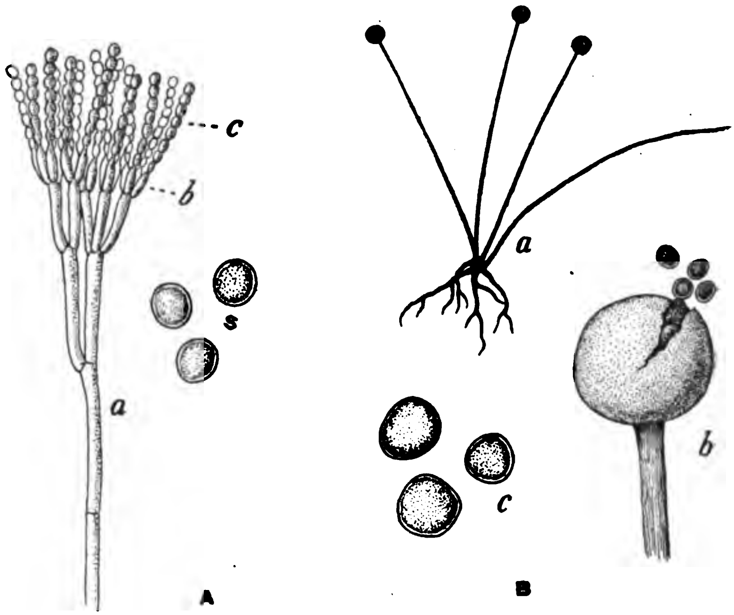

Fig. 14.—Blue mold fungus (in part), highly magnified, showing a branch spore-stalk (conidiophore), a, producing chains of spores (conidia), c; b, basidia; s, three spores more highly magnified. B, the fruit mold (in part), a, the common spore from this fungus consisting of minute stalks, each bearing a globular, black spore case (sporangium), at its apex, somewhat magnified; b, (sporangium), breaking open to discharge its spores; c, mature spores, very highly magnified. (Original.)

PINK MOLD.

(Cephalothecium roseum Corda.)

Fig. 15.—An apple showing pink mold following apple scab, and causing the decay of the fruit. (Original.)

This mold has been recently noted by Eustace as causing a great destruction of packed apples in New York. It has also proven a very serious cause of decay in this state during the past season. Greenings seem to be especially liable to its attacks although it has appeared abundantly on some other varieties. This fungus attacks the fruit in the wounds caused by apple scab, causing at first a brown discolored area around the scab. Soon the spot becomes partly covered with a pinkish moldy outgrowth of spore producing threads. The outbreaks of this fungus have been associated with two successive seasons of cool moist weather and may ordinarily not prove so destructive during years when such conditions are less prevalent. However, it may be expected to appear on badly scabbed fruit.

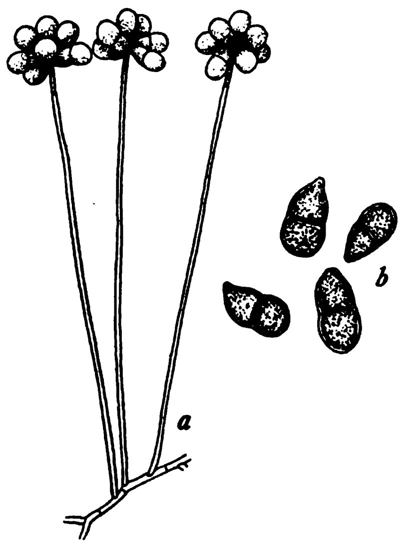

Fig. 16.—The pink mold fungus highly magnified; a, mycelium, giving rise to spore stalks, each bearing a cluster of spores at its apex; b, spores more highly magnified. (Original.)

PREVENTION AND TREATMENT.

The manner in which the fungi causing soft rot enter their hosts, namely through wounds or ruptures in the skin of the fruit, emphasize the need of keeping this protective covering as whole and sound as possible. Thus spraying with fungicides to reduce scab and with insecticides to keep off insect enemies which bite or bore into the fruit will greatly lessen the attacks by the soft rot fungi. Care in handling so as not to bruise or break the skin of fruit is also necessary to prevent loss from these sources. Cold storage, keeping the temperature below 45 degrees F. is also a valuable means of keeping fruit. Experiments in the dipping of apples in solutions of formalin, and exposing them to sulphur fumes have thus far failed to prevent the rotting of fruit thus treated. Similar experiments by others with copper sulphate solution and formalin have also shown that while some rots like the pink mold may be reduced, the blue mold is apparently not checked by such treatment. Frequent sorting of fruit in storage, removing all decaying specimens, also tends to decrease the loss from this cause.

DISEASES OF THE PEACH.

PEACH YELLOWS.

Fig. 17.—Peach Yellows. A, B, fruit from yellows affected tree, showing surface and flesh spotted and streaked with red; C, a prematurely ripened fruit on affected branch, which is attached to one bearing healthy foliage and fruit. a, stub of tree budded with bud from yellows affected tree, and showing the characteristic growth due to the disease, which has also affected the lower branch b; a, affected tree showing forced dormant buds which are giving rise to bunches of wiry twigs and narrow leaves; b, one of these clusters enlarged; c, a healthy leaf by the side of a branch bearing diseased foliage, showing the contrast in size. (A, B, a, b, after Erwin Smith, the others original.)

Although the disease known as Peach Yellows has been known in this country for more than one hundred years the real cause of the malady is still unknown. Like consumption in the human race "yellows" is one of the most dreaded of the diseases to which the peach is subject, for when once this insidious foe appears in a tree certain death is the result.

In bearing trees the premature ripening of the fruit is one of the first indica-

tions of the presence of yellows. This may occur from one to six weeks earlier than the normal period of maturing. Such fruits are also highly colored possessing red spots and streaks which often extend from the surface to the pit, the flesh being marbled and streaked with red. The buds formed during the summer, for growth the next season are also sometimes prematurely unfolded. But the most characteristic feature is the growth of bunches of slender twiggy branches during summer and autumn from the crotches and upon the older branches. These wiry shoots bear narrow sickly leaves of a yellow color and being produced in clusters give a characteristic appearance to affected trees.

Trees which show these characters—premature ripening of fruit— fruit spotted and blotched with red; twiggy, clustered shoots bearing small yellow foliage may be considered as unmistakably affected with yellows and should be at once condemned to the fire heap. Although the exact manner in which peach yellows is naturally spread from diseased trees is not understood, it is known to be contagious. Thus its appearance in one part of an orchard is almost certain to be followed by other cases unless the first trees to show it are removed without delay. Artificial infections may arise when buds from yellows-affected trees are used in budding, hence this means of dissemination should be guarded against by the use of buds from stock of unquestioned health. The spread of the disease by the use of pits from yellows affected fruit is believed to be small as such pits are not liable to germinate.

Control of Yellows—Thus far the only successful measures employed in combating the disease have been of a preventive nature. This consists of digging or pulling out and burning every tree which shows the characteristic symptoms of yellows and the more promptly this is done the better for the health of surrounding trees. Fertilizer tests with a view to lessening or preventing the spread of the disease have not been successful and the same may be said in regard to the matter of spraying.

Peach Rosette is a disease of the peach in the southern states. Its effects on the tree are similar to those of yellows and like that disease it is to be controlled only by destruction of affected trees.

LEAF CURL.

(Exoascus deformans.) (Burk.) Fckl.)

This disease affects the leaves of the peach causing great distortion. The leaf becomes thickened, bent and twisted, sometimes only in part or the entire blade may be affected, the fungus causing a blistered appearance very characteristic of the disease. A similar appearance is sometimes caused on leaves of peach, plum and cherry by the attacks of plant lice, but in this case the presence of the lice will usually indicate the true cause of the curling of the leaves. The trouble appears soon after the foliage is expanded causing the affected leaves to fall off. In severe cases, the trees may be entirely stripped of their foliage and normal growth seriously checked. Bearing trees lose their fruit for the season and often fail to form fruit buds for the next. A new crop of leaves generally appears after the falling of the first but the check is often so severe as to prevent the proper maturing of the new wood in time to resist freezing.

The fungous parasite lives through the winter in the form of mycelium in the buds and twigs of affected branches and grows out with the new leaves in the spring. It has been demonstrated, however, by recent investigations that most of the early infections of the foliage arise not from this hybernating mycelium but evidently from spores produced during the previous season. Thus it has been found possible even by a single spraying to reduce the number of infections 90%—98% which would not be the case if they arose from a perennial mycelium. The spores are produced in minute cells which cover the surface of the deformed leaves. The conditions which appear to favor the infection of healthy foliage are a low temperature with abundant rainfall during the early part of the growing season.

Treatment.—The fact that the mycelium of the fungus hibernates in the living buds of the tree would seem to point to the uncertainty attending any efforts to check the disease by spraying. But while spraying may not affect the disease already present in the tree it is very useful in preventing its spread to healthy leaves and the consequent establishment of the fungus in the newly forming buds. Hence in this case the use of fungicides is apt to show most

Fig. 18.—Peach leaf curl showing healthy and diseased foliage. (Taft.)

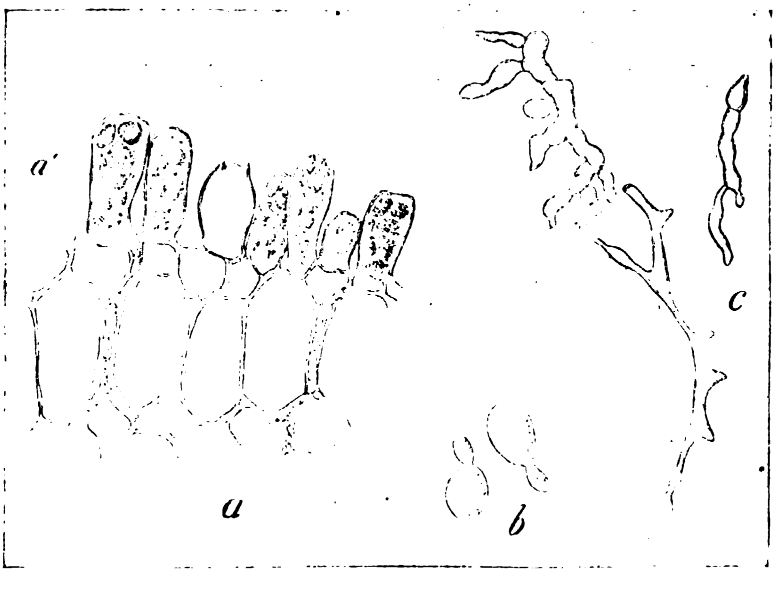

Fig. 19.—Microscopic structure of leaf-curl fungus. a, portion of section through affected leaf, showing the spore sacs (asci), a, seated on cells of the leaf; b, two spores budding like yeast cells; c, fragments of mycelial threads from tissue of affected leaf, all highly magnified. (Original.)

benefit during the season following the applications. The work of Prof. Taft in Michigan shows that very beneficial results may be expected from the use of one thorough spraying with copper sulphate solution two or three weeks before the buds open. This treatment if given before April 1 should entirely prevent the disease.

BROWN ROT.

(Sclerotinia fructigena (Kze. & Schm.) Norton.) (See Plum.)

CROWN GALL.

(Dendrophagus globosus Toumey.)

The disease known as crown gall has been noticed in Michigan only during the past six or seven years but it is already recognized as a serious foe to the culture of the peach. As its name indicates, trees affected with this disease show galls or knots of soft, corky or spongy tissue located most frequently at the crown of the root system, although they also occur on the roots and sometimes on the stem above ground. These knots when young have the same color as the roots but as they become older the surface darkens becoming rough and warty. They may vary in size from that of a hazelnut to bunches as large as one's fist. These galls usually begin to decay toward the end of the season and fall away, being followed by new galls on other portion of the roots. Thus a new crop of the galls is produced with each season. The effect of this disease on the trees is such as to produce a spindling or stunted, sickly growth, and usually leads to the death of the tree. Trees affected with crown gall when planted from the nursery seldom reach bearing size but frequently die the first season.

While many causes have been assigned for the formation of the galls characteristic of this disease the true one has been found to exist in the presence of an organism belonging to the myxomycetes, or slime molds. This matter has been determined by Toumey in Arizona who used almond seedlings infected with the disease for investigation. In its early stages the parasite consists of colorless microscopic masses of protoplasm which inhabit the cells of the knot. Under certain conditions these protoplasmic masses unite and come to the surface of the galls where small rounded spore-producing bodies are formed. The disease is spread most rapidly by means of infested nursery stock. There is evidence also that the disease may spread through the soil for limited distances and its contagious nature is clearly established.

Treatment.—The nature of this disease gives small hope in the matter of a cure, hence prevention is the chief source of relief. Some benefit has been derived from the removal of the knots which form at the crown of the roots and painting the wounds with a paste composed of copper sulphate and lime. Other galls will form on the roots further underground but are not considered of as much importance as those which occur on the crown. In most cases, however, it will be better to dig out and burn affected trees. Careful inspection of nursery stock should be made before planting and all affected trees rejected and burned. Crown gall is also belived to be communicated to the peach from the raspberry and blackberry but especially from the former. Hence the planting of raspberries between the peach rows is to be avoided as galls are quite commonly found on the former.

SCAB.

(Cladosporium carpophilum Thom.)

The disease known as peach scab, or merely "scab," causes dark colored velvety spots which are frequently most numerous on one side of the fruit. When the spots are very numerous they run together and in bad cases cause the fruit to harden and crack open. In such instances too the fruit often fails to develop evenly but is one sided. The disease is especially common on certain kinds, some seedling varieties seeming to be especially susceptible to its attacks. While the peach scab, like that of the apple, is confined to the surface of the fruit its effects may be such as to render the crop almost worthless and even in moderate cases the market value of the fruit is apt to be materially reduced. This fungus also sometimes causes spotting and shothole effects on the foliage. The disease is most prevalent during rainy seasons. It also attacks the plum and cherry.

Treatment.—While scab is a surface parasite it is not as readily controlled by fungicides as might be expected from that fact. Nevertheless persistent spraying with Bordeaux mixture has been found to materially reduce the amount of scab.

Fig. 20.—Peaches affected with the scab fungus, showing gum oozing from cracks in the fruit. (Original.)

LITTLE PEACH.

Within the past few years a serious disease of the peach which has come to be known as "Little Peach" has appeared in the western fruit belt of Michigan. Dr. Erwin F. Smith of the Department of Agriculture, Washington, D. C., who has made extensive investigations of the peach yellows disease has also studied the little peach and from a paper by him on this subject the symptoms which characterize the disease have been taken. 1. The Little Peach, as its name implies, produces a dwarfing of the fruit. 2. The fruit is retarded in ripening. 3. There is no red spotting of skin or flesh. 4. The leaves are dwarfed and yellow from the beginning. 5. The winter buds do not sprout in Peach Yellows. In most cases these symptoms differ decidedly from those of yellows with which this trouble is apt to be associated by persons not familiar with that disease.

So far no definite cause leading to this disease has been discovered, although the subject has been carefully studied during the past season. So far as noted, the trouble is not confined to trees of any particular age, variety, or location as to soils, although the majority of attacks seem to occur on trees over five years of age and on the heaviest bearers such as Chili, Gold Drops and Smock.

While no specific organism of a parasitic nature has been assigned as the true cause of little peach the trouble is apparently one originating in the underground portions of the tree, thus leading to the reduction or cutting off of the water supply. Thus far the only method which seems capable of holding this disease in check is the prompt removal and destruction of the affected trees. This is the treatment which is being followed by the most extensive growers of the peach and the same that has been successfully employed in checking the extension of the yellows.

Other fungous diseases of the peach of less importance to Michigan peach growers.

RUST.

(Puccinia pruni-spinosae Pers.)

The rust which attacks the leaves of the peach in some portions of the country also affects the leaves of the cherry and plum. This fungus is closely related to the rust of grain (*Puccinia graminis*) and causes rust-like spots on the lower

surface of the leaves which are induced to fall off prematurely. This disease is troublesome in the southernmost states.

PEACH MILDEW.

(Sphaerotheca pannosa Lev. & Podosphaera oxyacanthae (D. C.) D. By.)

Mildew attacks leaves and twigs and later the fruit also, covering the former with a whitish coating and on the latter producing spots of a light color, hardening of the flesh and an abnormal development of hairs or fuzz. Only those varieties which have serrate margined leaves and do not possess glands on the leaves seem to be affected. It is readily controlled by copper sulphate solution and Bordeaux mixture.

BROWN OR PUSTULAR SPOT.

(Helminthosporium carpohilum Lev.)

This disease was first noticed in Michigan in 1893 as being most common on the Wager variety. Affected fruit shows small, rusty spots which gradually increase in size after the fruit begins to ripen. The disease is confined to the surface of the fruit hence is readily controlled by spraying with fungicides.

CONSTRICTION DISEASE OF STEM AND BRANCH.

(Phoma persicae Sacc.)

A disease which causes a groove-like constriction of the stems and branches of peach trees due to a fungous parasite has been described as occurring on nursery stock and on young shoots of older trees in Ohio. The portions of the stem or branch above the constriction die back. Cutting off the affected parts below the constriction is recommended, the removed portions to be burned.

SHOT HOLE FUNGUS.

(Cylindrosporium padi Karst) (See Plum).

LEAF SPOT FUNGI.

Several fungi of a more or less parasitic nature have been noticed as occurring on peach leaves, being associated with spotting of the foliage. Among these are *Macrosporium commune Rabh.*, recorded as frequent in Ohio, and *Cercosporella persica Sacc.* The latter fungus produces a frosty growth on the under surface of the spots. It is more common in the south than here. Neither of these fungi is to be regarded as serious in its effects.

Cercospora circumscissa Saac, also causes spotting of the leaves of the leaves of peach, cherry, almond and apricot, the pieces of dead tissue falling out later thus giving rise to a shot-hole effect.

PLUM DISEASES.

BLACK KNOT.

(Plowrightia morbosa (Schw.) Sacc.)

Black knot of the plum and cherry is one of those destructive fungous diseases the effects of which are quite liable to be mistaken for the attacks of some insect parasite. In fact, for a long time it was believed even by scientists that the peculiar black, knotty growths which often appear on these trees were due to this cause. It is definitely known, however, that these knots are the direct result of the presence of the mycelium of a fungous parasite in the tissue of the branches and that insect larvæ when found are merely feeding on the swollen tissues. The first evidence of the presence of this disease is the formation of irregular, knotty swellings on the young growth, the knots often extending along the branch more on one side than on the other, in such cases the branches being frequently much curved or distorted. At first these knots possess a dark olive

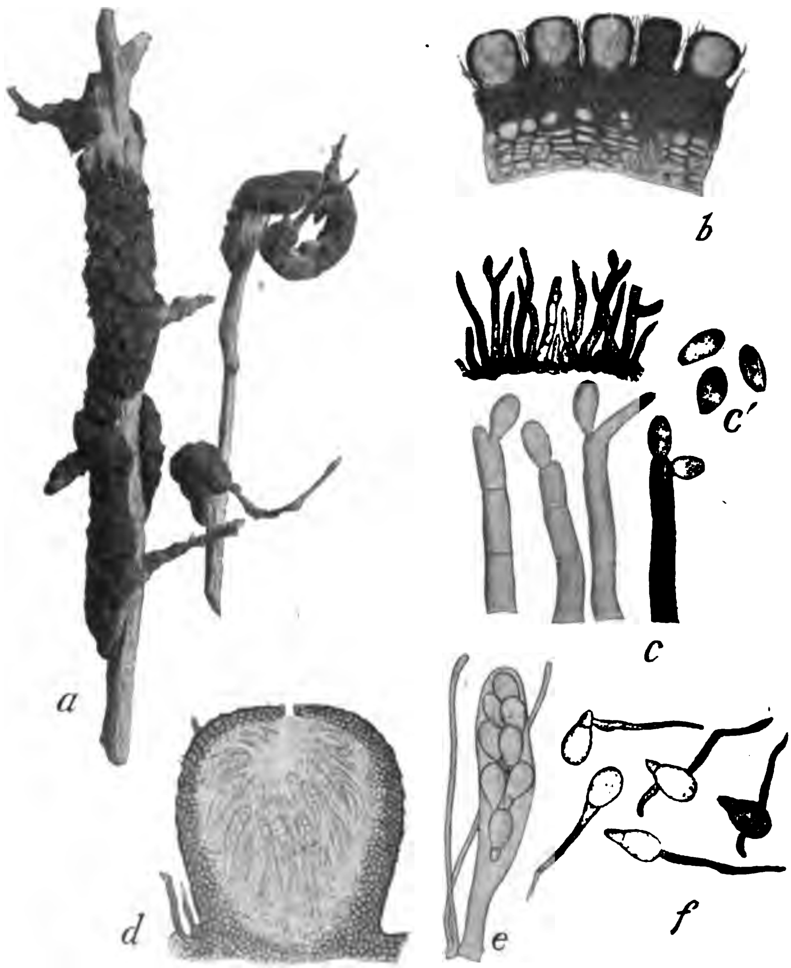

Fig. 21.—Black Knot fungus. a, mature knots on plum branches; b, magnified section of a knot, showing the spore cases (perithecia); c, spore stalks (conidiophores), which grow on the surface of the knots when young and give rise to summer spores (conidia), c; d, section of a winter spore case (perithecium), more highly magnified, showing numerous contained spore sacs (asci), one of which is shown very highly magnified at e; f, several of the two celled winter spores germinating in water. (Original.)

color and a velvety surface. This appearance is due to the great number of minute spore-bearing stalks which grow on the surface of the knot. The spores shed from the velvety knots are capable of infecting other branches during the present growing season so that the knot becomes a source of contagion even in its early stages. Late in the winter the knot has lost its velvety appearance leaving a dead black, uneven, more or less cracked surface. Under a hand lens the outside appears to consist of small, closely crowded pimples or pustules with a minute depression in the center of each. A section through one of the knots, when examined under the compound microscope, shows these pustules as hollow, thick-walled bodies lined with a layer of club-shaped cells (asci) containing spores. These are the winter spores and serve to start the fungus anew the next season. Hence the knots if left on the trees over winter also serve once more as

centers of infection. Furthermore, the mycelium which has caused the knot is capable of spreading into any new shoots which may arise near it. Sometimes trees become so badly infested with this disease as to present a mass of knotted limbs which have just enough vitality to push out a few leaves and make a feeble growth, while many of the branches die each season.

Treatment.—As the knots form early in the growing season they should be removed at once and not left to produce spores. The branch bearing the knot should be cut several inches below the swelling to remove all mycelium. Burn the knots as soon as removed. While the thorough removal of the knots will usually serve to keep this disease in check it may be advisable to spray with some fungicide especially if there are wild cherry trees or other plum trees in the neighborhood on which the disease is allowed to exist.

BROWN ROT.

(Sclerotinia fructigena (Kze. & Schm.) Norton.)

This fungus undoubtedly destroys more plums thany any other one disease. It is also very destructive to peaches, especially the early varieties which frequently rot badly on the trees and in transportation and storage. The cherry

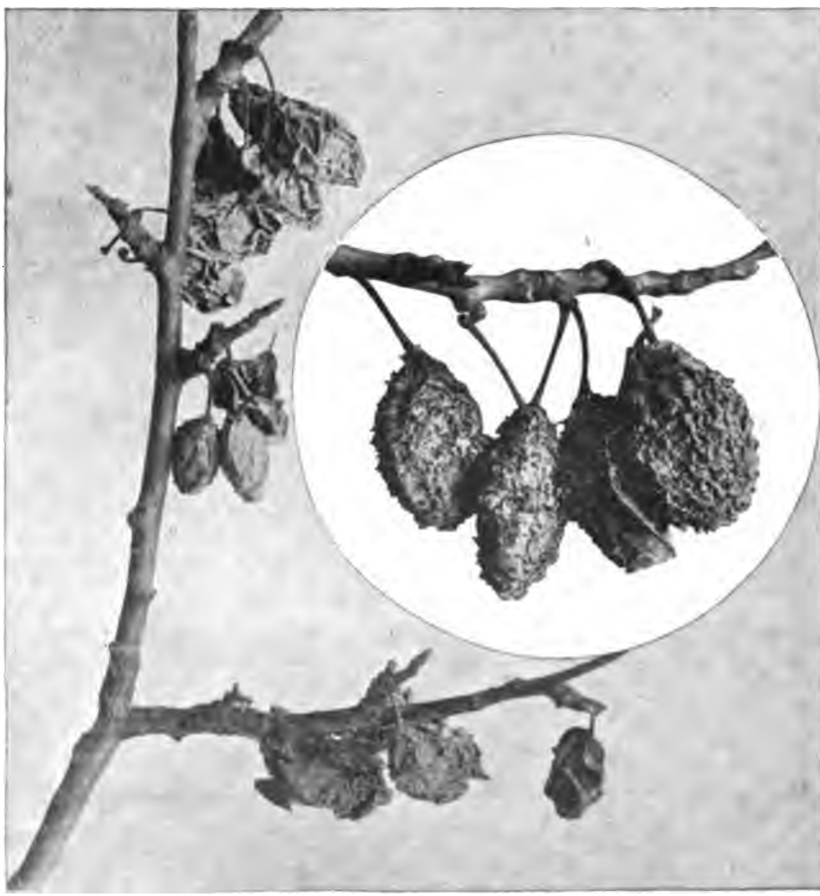

Fig. 22.—Plums affected with brown rot found on trees in February, showing mummified condition. These plums still retain the ability to give off spores (conidia).

too, is subject to this disease which often attacks the blossoms, leaves and young shoots as well as the fruit. It is also not uncommonly found on apples, especially early varieties, and has been induced to grow on raspberries, blackberries and numerous other fruits. In fact this is one of those fungous pests which seem capable of adapting itself to almost any of the horticultural fruits although it is especially common on the stone fruits. Among plums, the Japanese and American varieties seem less subject to the brown rot than the European or "Domestica" type. Of the latter the Lombard is especially subject to this disease.

The disease manifests itself on the fruit by the formation of a rapidly enlarging, brown discoloration, hence the name brown rot. Sometimes only a few hours are needed for this fungus to cause the decay of affected specimens. Plums which have been bitten by the plum curculio and the plum gouger are almost sure to decay by means of the brown rot, the spores of which are enabled to infect the fruit in these wounds. After the disease is well established the epidermis of the fruit becomes ruptured in many places by the spore-bearing branches of

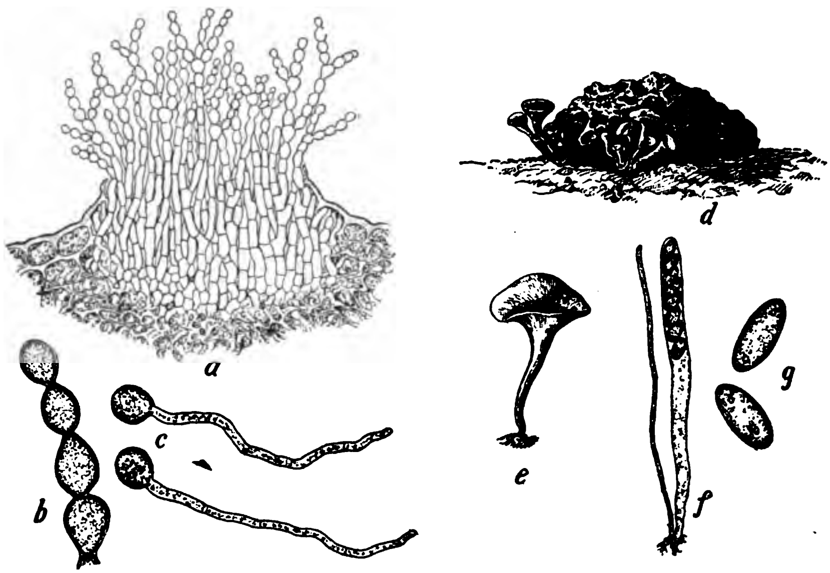

Fig. 23.—a, section through a diseased plum showing a spore pustule bursting through the skin of fruit and producing chains of spores (conidia); b, part of a spore-chain; c, spores germinating in a drop of water (all highly magnified); d, an old mummy plum which has lain on the ground over winter, giving rise to small fleshy outgrowths (ascophores in form like little wine glasses; e, one of these outgrowths somewhat enlarged; f, some of the slender spore sacs (asci), which line the cup like part of the fleshy organs shown at d, e; g, mature spores from a spore sac, highly magnified. (Original.)

the mycelium which push out in little tufts. These ash-colored tufts have a powdery appearance due to the great number of spores (conidia) given off. When several plums are in contact with an affected one they are all pretty sure to rot and instead of falling off remain on the trees nearly all winter. One of the most common sights in the average plum orchard during winter is furnished by these mummy fruits which were attacked by the brown rot during the previous summer. In spring these diseased plums become softened by rain and the dormant mycelium which they contain may give rise to another crop of spores (conidia). Another spore-form has been recently discovered. Thus when the mummified fruits have lain partly covered with soil on the ground they may give rise in spring to little fleshy outgrowths somewhat resembling wine glasses with long stems. The cup-shaped part of these outgrowths is lined with a spore-bearing layer in which are minute spore sacks (asci) each containing eight spores. When mature these spores are discharged and may infect the new crop of fruit. The brown rot fungus sometimes attacks the tender foliage and young shoots

causing them to turn brown. When the fungus gains an entrance into wounds on branches it may cause a kind of canker from which a flow of gum is the result. The writer has frequently seen "gumming" of the shoots of the flowering almond with consequent death of the upper portion due to this fungus.

Treatment.—A fungus which can thrive on so many hosts is not easily prevented from occurring in the orchard. The fact, however, that the mummified fruits serve to carry this fungus through the winter should indicate the need of gathering and burning them instead of leaving them, as is usually the case, to serve as centers of infection. Thorough spraying with Bordeaux mixture and other fungicides, while reducing the amount of the brown rot, seldom succeeds in entirely preventing it. It has been found that where insecticides are used, thereby reducing the attacks of the curculio that the brown rot is less severe. This is also the case when the trees are jarred for the same purpose. This process serves not only to remove the curculio to quite an extent but also causes most of the rotting plums to fall off, thus removing one cause of the spread of the fungus. Thinning the fruit will aid in controlling this disease. The trees should be thoroughly sprayed before the buds open, with poisoned Bordeaux or a solution of copper sulphate, one pound to twenty-five gallons of water, then again with Bordeaux just before blooming, and again just after blooming to be followed by another spraying when fruit is three-quarters grown. Ammonia-copper carbonate solution should be used when the fruit begins to color.

PLUM POCKETS.

(Exoascus pruni Fckl.)

The disease known as plum pockets or bladder plums is due to a fungous parasite which is closely related to that of the leaf curl disease of the peach. Like that disease it possesses a hybernating mycelium which lives in the tissues of the twigs and young branches. When growth begins in spring this mycelium grows out into the young ovary of the blossoms. Soon after the petals fall the young fruits become swollen and often lengthened or distorted. When cut open they are found to be hollow and without a pit as the stone fails to develop. These bag-like fruits are at first yellowish tinged with dingy red and later appear to be covered with a whitish bloom. This appearance is due to the numerous minute spore-sacks (asci) which cover the surface of the diseased plums. After the spores are discharged from these spore sacks the plums turn dark and fall off.

Treatment.—Trees which are once affected with this fungus continue to bear bladder plums year after year. Cutting off those branches which show the disease, as soon as noticed, will tend to prevent its further spread. However, when a tree is thoroughly infected so that all the fruit is diseased it may better be dug out and burned. Plum trees which are sprayed each season are not liable to be infected with this fungus.

SHOT-HOLE FUNGUS.

(Cylindrosporium padi Karst.)

Several fungous diseases are known to produce shot-hole effects on the leaves of plants. The above named fungus, however, is most commonly associated with that trouble on the foliage of plum and cherry. Affected leaves become disfigured with numerous small spots of dead tissue which soon separates from the healthy portion and drops out leaving perforations suggestive of the name shot-hole disease. The spores are produced in minute pustules in these dead pieces of leaf tissue. When severe, the leaves fall off prematurely thus causing a serious check to the maturing of fruit and wood.

Treatment.—Where this disease is prevalent about two or three sprayings of Bordeaux mixture will be needed to prevent it, although a single application may prove very beneficial. The first application should be made when the leaves are well out and before they are inoculated by the spores of the disease. The other applications, if needed, may be used at intervals of two or three weeks.

Fig. 24.—Leaf plum affected with the shot hole fungus.

GUMMOSIS OR GUMMING OF STONE FRUITS.

The flow of gum from branches of plum, peach, cherry, almond, etc., has in some cases been attributed to the presence in the tissues of a parasitic fungus. Thus Massee describes a gummosis of the flowering almond due to the attacks of *Cladosporium epiphyllum* and a similar trouble on the same plant has been noted by the writer under the head of Brown Rot of Plum (*Sclerotinia fructigena*).

Cladosporium epiphyllum has also been found causing gummosis on the purple-leaved variety of the Myrobalan plum grown for ornament at the Agricultural College while the same disease on cultivated plums has been found to be associated with a species of Cladosporium. In many cases the trouble probably begins in some crack or wound which allows the fungous parasite to gain an entrance. The presence of the mycelium induces a flow of sap which exudes and hardens forming tear-like drops, sometimes of considerable size. This gum is partly utilized by the fungus in the production of more spores. The portion of branch beyond the affected spot may in some cases be killed or permanently weakened. In such cases the branch should be cut off below the diseased area and burned. The use of fungicides will serve to reduce the tendency toward gumming.

Boring insects of the peach, plum and cherry may also cause a flow of gum from the wound made in entering and these wounds probably often serve to allow the entrance of fungi, hence the desirability of combating the insect enemies of these trees.

DISEASES OF THE CHERRY.

POWDERY MILDEW.

(Podosphaera oxyacanthae (D. C.) De By.)

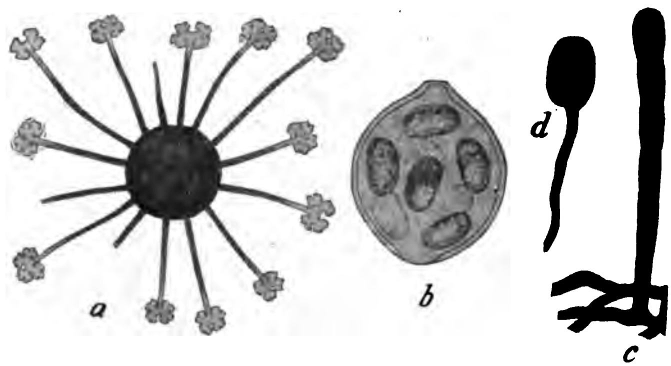

Fig 25.—Powdery mildew of the cherry, etc. A, a winter spore case (perithecium) magnified, showing the appendages with peculiarly branched tips; b, the one large spore sac (ascus), containing eight spores, which is contained in the spore case, a; c, the summer spore form of the fungus showing the formation of spores (conidia), by the dividing of a spore stalk (conidiaphore); d, a spore germinating in water. (Magnified, original.)

The powdery mildew is a superficial fungus, that is, it spreads over the surface of the host plant merely sending short sucker-like growths (haustoria) into the epidermal cells. These serve alike the purposes of hold-fasts and feeding organs for the parasite. This disease appears on the foliage producing a white, moldy appearance due to the numerous mycelial threads which form a delicate felt-like layer. From these threads arise minute, erect stalks which divide into a number of cells each of which becomes an egg-shaped spore. The great number of these spores forming on the surface of the leaf gives a powdrery appearance suggestive of the common name. These are the summer spores. They germinate as soon as they fall into a drop of moisture and if in contact with a young cherry leaf set up the disease. Later in the season dark brown specks appear among the matted threads of mycelium, each armed with a number of thread-like appendages furnished with peculiarly branched ends. These dark bodies are the resting spore cases which remain dormant through the winter and give off several spores in the spring to start the disease anew.

The powdery mildew, while not often serious on large trees, may cause much damage to the leaves and tender shoots of seedling cherries in the nursery. The same disease is common also on the foliage of the plum, young apples and hawthorn.

Treatment.—Trees which are treated for shot-hole and brown rot with Bordeaux mixture will need no further treatment for this disease. For seedling trees the sulphide of potassium solution or the ammonium copper carbonate mixture may be used.

RUST.

(Puccinia pruni-spinosae Pers.) (See on Peach.)

SCAB.

(Cladosporium carpophilum Thum.) (See Peach Scab.)

The cherry is subject to a number of diseases common to the plum. Among these the following are described under the head,—

Black Knot (*Plowrightia morbosa* (Schw.) Sacc.).

Brown Rot, Fruit Mold (*Sclerotinia fructigena* (Kze. & Schm.) Norton).

Shot-hole Fungus, Leaf Spot (*Cylindrosporium Padi Karst*).

DISEASES OF THE GRAPE.

BLACK ROT OF THE GRAPE.

(Guignardia Bidwellii (Ell.) V. & R.)

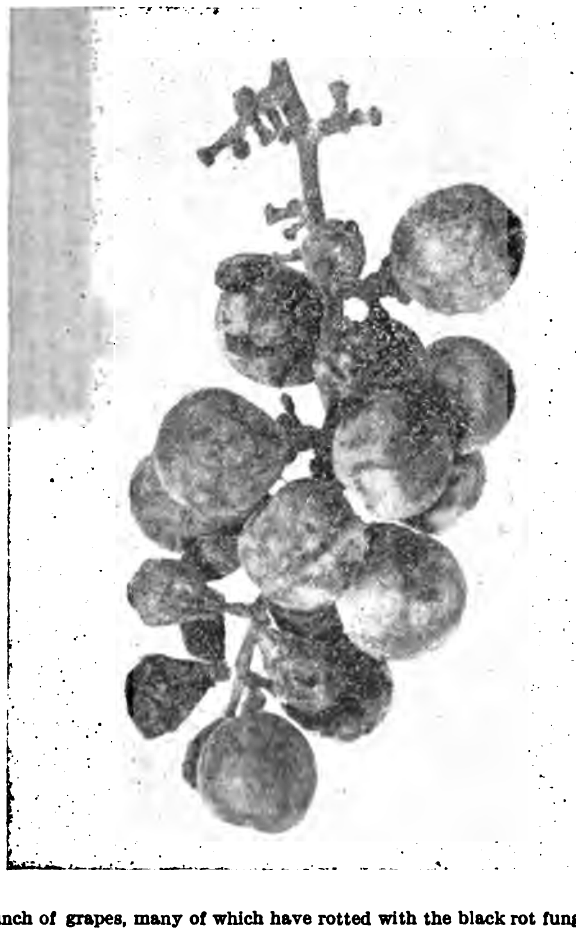

Fig. 26.—A bunch of grapes, many of which have rotted with the black rot fungus. (Original.)

Among the numerous fungous diseases to which the grape is subject no other is so destructive to the fruit in this country as the one known as black rot. Thus the labor and fruit of a season may be swept away in a few days when the conditions are favorable. In some places grape growing, once a profitable industry, has been almost entirely abandoned on account of the ravages of this fungous parasite.

The disease attacks all parts of the vine except the roots. The leaves and young shoots first show its effects by the appearance of brownish spots of dead tissue. The fruit is often attacked when only half grown although the greatest destruction usually follows a warm, moist period of weather a little before ripening. Affected berries first show brown or dark colored spots which rapidly

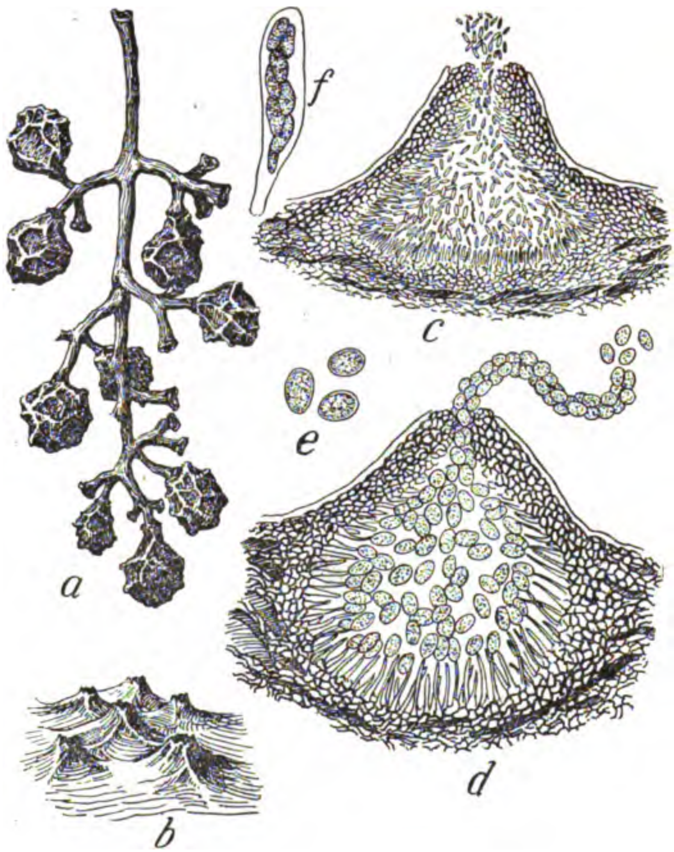

Fig. 27.—A, Concord grapes diseased with black rot, and found hanging on vines in March; b, small portion of surface, magnified, of diseased grapes, showing pimples or pustules; c, section of a pustule, showing formation of numerous minute, spore-like bodies (spermatia); d, section of another pustule which produces the summer spores which are seen oozing out of the protruding mouth; e, separate spores; f, a spore sac (ascus), containing eight winter spores, which are produced in a pustule, similar to d, on the diseased grapes which lie on the ground over winter. (d, e, f, after Scribner, in part, the others original.)

enlarge until the whole berry is involved. Wrinkling of the fruit due to drying, then takes place, the affected berries remaining attached to the stems. Such fruits possess a black, strongly wrinkled surface studded with minute points or pustules which lie just under the skin. These little pustules are spore-forming organs and have a small projecting mouth through which the spores are discharged when the grape is wet. On becoming dry these microscopic spores may be carried to other parts of the plant or vineyard thus serving to disseminate the disease during the growing season. Other spores produced in another manner also serve the same purpose.

The old grapes and diseased leaves, moreover, when left on the vines or lying on the ground give rise to another spore form, the spores being produced in spore sacks (asci) contained in little cavities (perithecia). This spore form remains dormant until spring thus carrying the disease through the winter.

Treatment. The fact that the old diseased leaves and grapes are the hibernating places of this fungus points out the need of destroying them before growth begins in spring else the disease is almost sure to reappear. Raking and burning

all trimmings and burning all diseased fruit as fast as it appears has served in some cases to hold this disease in check. Spraying with Bordeaux at the first appearance of the disease if thorough and persistently followed will in most cases serve to control the black rot. One spraying with copper sulphate solution before growth begins should be made, and after leaves are out Bordeaux mixture should be applied at intervals of two or three weeks until grapes are about half grown. After this some clear fungicide may be used, such as weak copper sulphate solution, ammoniacal copper carbonate or soda Bordeaux which will not stain the fruit. Sprayings, in many cases, will not need to be continued after August first.

DOWNY MILDEW.

(Plasmopara viticola B. & C.)

Fig. 28.—Leaves and young growth of grape attacked by the downy mildew. The upper surface of the leaves shows brownish spots, while the lower side gives rise to a whitish, downy growth.

As a destructive disease of the grape the downy mildew probably holds the highest rank. It affects all tender growing parts of the vine. On the leaves it first produces pale spots on the upper surface. These spots soon become brownish while on the lower side of the leaf a whitish downy outgrowth appears suggestive of the common name. This appearance is due to the formation of

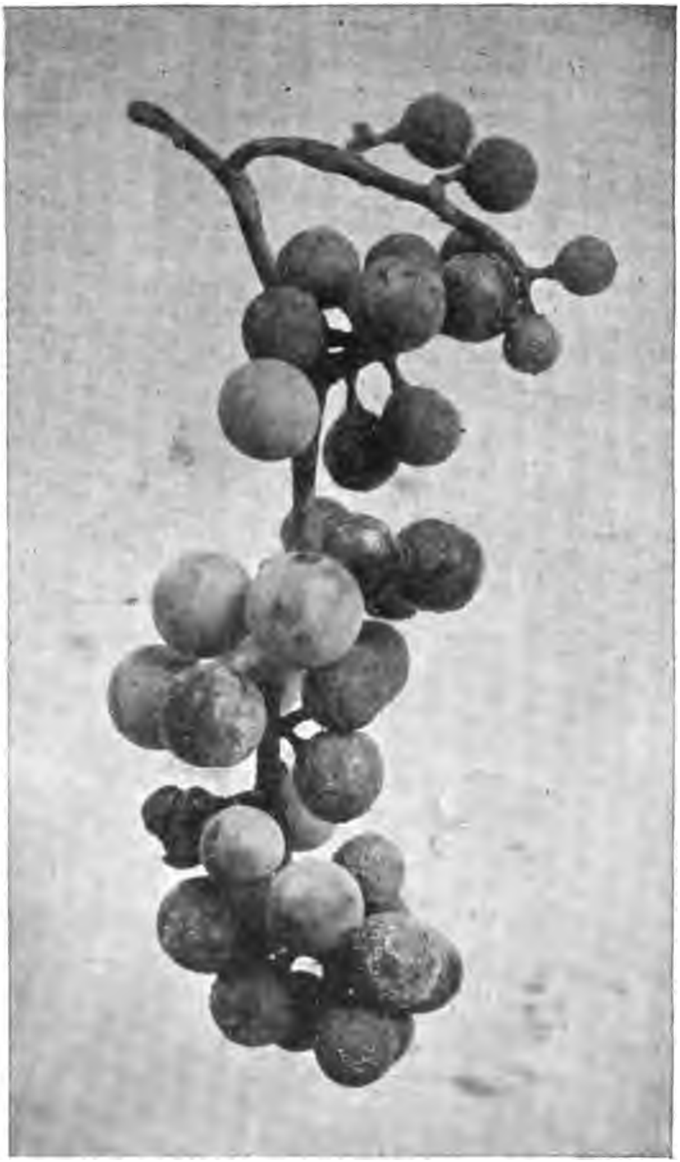

Fig. 29.—A bunch of grapes attacked by the downy mildew.

immense numbers of spore bearing branches which grow out in tufts through the stomata in the lower epidermis. Each branch produces many egg-shaped spores (conidia) which may germinate at once if moisture is present. In germinating each conidium gives rise to several minute protoplasmic bodies (zoospores) capable of swimming about in a drop of water for a short time but soon coming to rest. They now send out a germ tube which may enter the host plant thus

causing infection. Young shoots are also affected being soon killed by the rapidly spreading mycelium which passes between the cells, into which short sucker-like projections (haustoria) are sent. In this way the vines may be much weakened. The berries are usually affected when only partly grown. On these the fungus produces brownish spots which rapidly enlarge soon involving the whole fruit, which may also be covered with downy patches of the fungus. The brown color assumed by the fruit, when attacked, has also given the name brown rot to this disease.

Within the diseased tissues another form of spore is produced which serves as a resting or winter spore. These are larger than the summer spores, possess a heavy, dark colored outer coat, and hibernate in the tissues of the affected parts which may be left in the vineyard. The downy mildew thrives best during moist weather. It usually appears somewhat later in the season than the black rot disease.

Treatment. When the black rot and downy mildew occur together, as is quite common, no other treatment will be required than for the former. For the mildew alone, sprayings with the ammoniacal copper solution have been found efficacious. The standard Bordeaux mixture or the soda Bordeaux may be substituted.

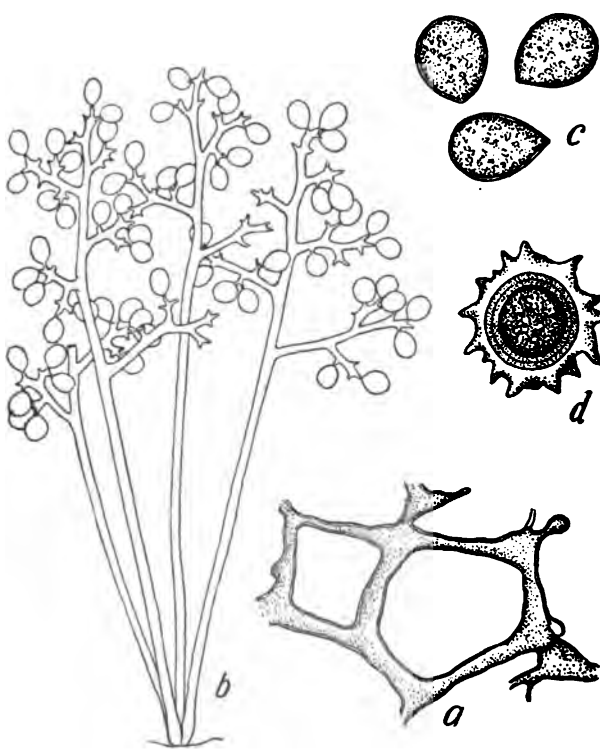

Fig. 30.—Microscopic structure of the downy mildew fungus. A, small portion of the mycelium from a diseased grape; b, a tuft of spore stalks, (conidiophores), which gives the downy appearance to affected parts of the host plant; c, mature spores (conidia), produced during summer; d, thick walled, dark colored resting spore from diseased tissue of grape, highly magnified; (d, after Viala, others original.)

POWDERY MILDEW.

(Uncinula spiralis B. & C.)

The powdery mildew is not apt to prove very troublesome to vineyardists in this state except in graperies and upon European hybrids which are more subject to it than those of native origin. This disease is confined to the surface

of the host plant merely sending short suckers (haustoria) into the epidermal cells. It may attack any of the new growth but is most noticeable on the upper surface of the leaves which appear covered with a white moldy growth possessing a powdery appearance. This is due to the great number of spores (conidia) which are produced from upright branches of the mycelium. These are shed in abundance during summer thus serving to spread the disease during the growing period. Later the affected parts show, under a hand lens, minute black bodies scattered about where the mycelium was most abundant. These are the winter spore-cases (perithecia). In spring they burst open thus allowing the escape of the enclosed spore sacks (asci).

Treatment. Where treatment for no other fungous diseases is required sulphur in the powdered form is usually used. This may be dusted on the vines when dew is on. A solution of sulphide of potassium, one ounce to two gallons of water, may also be used as a spray. The ammoniacal copper solution is also recommended where the disease is of yearly occurrence.

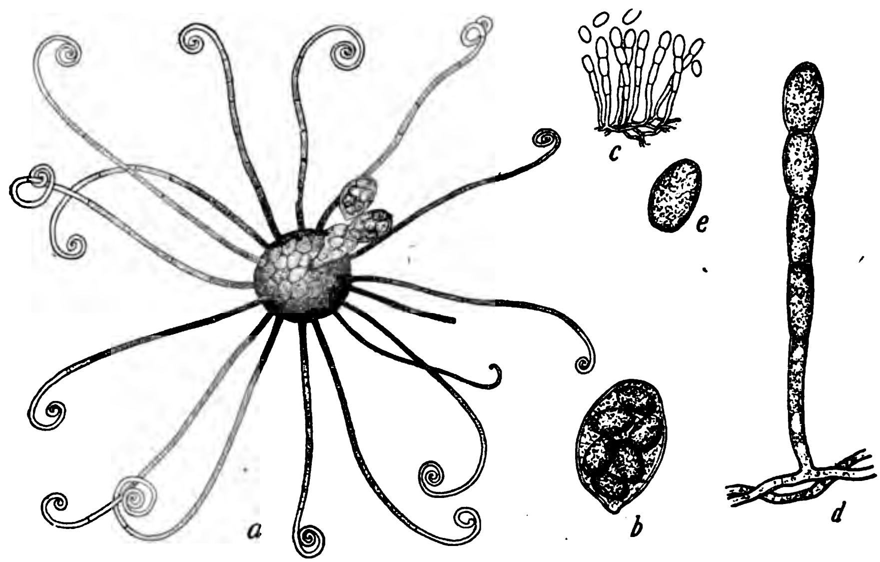

Fig. 31.—Microscopic structure of the powdery mildew fungus. A, a winter or resting spore case (perithecium), bursting open to discharge the contained spore sacs, (asci); b, a spore sac (ascus), showing contained spores; c, mycelium from surface of leaf, giving rise to spore stalks (conidiaphores), which break up into spores, thus producing the powdery appearance of affected parts; d, one of the spore stalks, highly magnified, showing how the spores (conidia), are formed; e, mature summer spore (conidium). (Original.)

ANTHRACNOSE, BIRD'S EYE ROT.

(Sphaceloma ampelinum De By.)

The disease known by the above names does not seem to have proven as serious a trouble to the grape growers of Michigan as of some other states. However, it has been noted from various localities and should be watched for each season by those who grow this fruit to any considerable extent. It affects all the young growing parts of the vines but is apt to be more noticeable when seen on the fruit. The affected berries show, at first, brown spots which are surrounded by a clearly defined margin. The center of the spots later becomes whitish in color while the slightly raised margin assumes a deep brown or purplish hue. Sometimes there is an inner circle of red color which helps to accentuate the light center of the spots and gives to them the appearance suggestive of a bird's eye. If several spots appear on a berry it soon shrivels up, sometimes, however, only one side may be affected while the other develops thus

leading to a one sided fruit which sometimes cracks open exposing the seeds. The diseased spots are dry and do not extend deeply into the fruit but somewhat resemble the spots of apple scab in their nature.

The spores are produced on the surface of the central portions of the diseased spots. They may be disseminated by rain or currents of air and when lodged on healthy berries in a drop of water soon give rise to the spots characteristic of the disease. While it is not definitely known as to how the fungus passes the winter it is possible that the diseased portions of plants may be the means by which this is effected.

Fig. 32.—Grapes affected with anthracnose.

Treatment.—Removal and burning of affected portions of the vine are to be accompanied by spraying with some of the standard fungicides as for black rot. Treating the vines during the winter with a solution of sulphate of iron to which has been added a portion of sulphuric acid, is also recommended.

RIPE ROT.

(Glomerella rufomaculans) (See on apple.)

Grape diseases of uncommon occurrence in Michigan.

Bitter rot (*Melanconium fuligineum* (Scrib. & Vial.) Car.) has been noted as occurring in some of the eastern states. It resembles in appearance and effects the ripe rot fungus but imparts a very bitter taste to the diseased fruit.

White rot (*Coniothyrium diplodiella* (Speg.) Sacc.) has been found in Missouri on young shoots and fruit of the grape. The latter assumes somewhat the appearance of that affected with black rot except the color, which does not darken.

Root rot (*Armillaria mellea* (Wallr.) Fr. and *Dematophora necatrix* Hartig.). These two fungi which cause the rotting of the roots of the vine in Europe have also been found, but to a less extent, in this country. The former is a mushrooms of common occurrence in this state in woods and clearings or where there is decaying wood in the soil. So far as the writer is aware it has not been noticed in connection with the rotting of grape roots in this state. The latter fungus is mold-like in its fruiting or spore stage. Both fungi form root-like strands or cords of mycelium but those of the latter fungus are light in

color and delicate while those of the mushroom are dark brown or black on the outside. These fungi spread by means of their underground mycelium as well as by spores. Vines which are on poorly drained soil are most apt to suffer from root rot. Good drainage and the prompt removal of diseased plants are recommended as preventatives.

Leaf blight (*Cercospora viticola* (Ces.) Sacc.) causes irregular dark brown spots of dead tissue on the leaves of the grape. It occurs in most of the eastern states but is not usually found to be severe in the more northern portions of this region. It is apparently of little importance to the grape growers of Michigan.

CURRANT DISEASES.

Leaf-spot (Septoria ribis Desm. and Cercospora angulata Wint.)

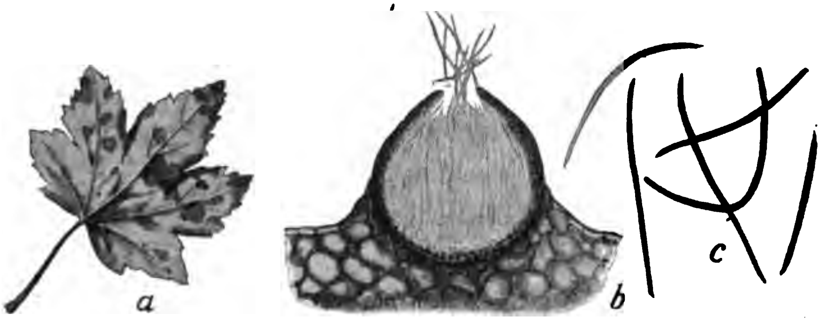

Fig. 33.—a, Leaf of currant affected with the leaf spot disease; b, a spore producing pustule magnified, from a diseased spot of a leaf, giving out long, slender spores, a few of which are shown highly magnified at c. (Original.)

The fungi causing leaf-spot of currant and gooseberry are common and destructive to the foliage in this state. Affected leaves at first show small brownish spots during June or July and by August the foliage begins to drop. It is not unusual to see bushes entirely defoliated by this disease long before frosts. Thus the plants are prevented from making a complete growth or of properly perfecting the fruit buds. The spores of these diseases are produced on the dead portions of the diseased leaves on which the fungi also hibernate.

Treatment. Rake and burn all dead leaves and rubbish in spring. It has been found possible to reduce the attacks of these fungi to a great extent by the use of fungicides applied at intervals of two or three weeks, during the growing season, the first application to be made early in June. Even two or three applications will materially reduce this trouble. The spray used early in the season, while the fruit is on, should be one of the clear mixtures so as to avoid staining the berries. After harvest Bordeaux mixture may be substituted.

ANTHRACNOSE OF CURRANTS.

(Gloeosporium Ribis (Lib.) Mont. & Desm.)

This disease causes a spotting of the leaves of the cultivated currant but seems less common than the previously mentioned fungi. Its first appearance is made early in summer and like the other leaf-spot fungi causes the leaves to turn yellow and fall off prematurely. The fungus itself produces small brownish spots on the foliage and in the diseased areas the spores are produced. They are one-celled curved bodies of minute size.

Treatment.—If the bushes are treated as for the leaf-spot fungi the anthracnose should not be troublesome.

KNOT.

(Nectria cinnabarina (Tode) Fr. and Plenoectria Berolinensis Sacc.)

A Disease of Currants is the title of Bul. 125 of the Cornell Experiment Station. In this bulletin is described a currant disease due to the attacks of two species of fungi which have caused serious trouble in some plantations in New York state. The disease attacks the canes causing the foliage to turn yellow and fall off, eventually leading to the death of the canes. The fruit also ripens prematurely and is of small size.

The fungus appears on the canes in the form of small pinkish cushion-like tubercles usually most abundant near the ground. From these tubercles spores are produced in abundance which are capable of growing at once. Another spore form is produced later in the history of the fungus on the dying or dead canes. It is believed that infection occurs largely through wounds or cuts but after once gaining an entrance the disease becomes deep seated and difficult to eradicate. Spraying is not recommended as being of much service in combating the disease. All diseased plants should be dug out and burned and cuttings made only from bushes in plantations entirely free from the trouble. It would also be advisable to locate new plantations on soil not previously occupied by affected plants.

GOOSEBERRY DISEASES.

GOOSEBERRY RUST.

(Aecidium grossulariae Schum.)

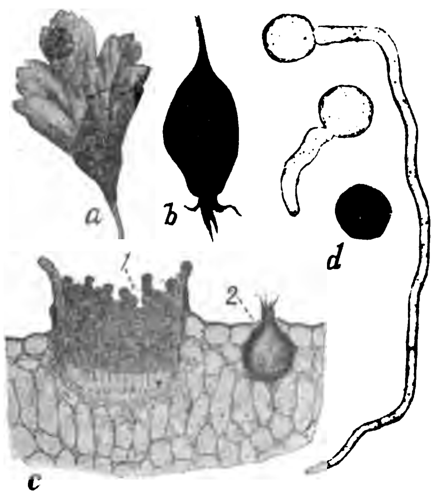

Fig. 34.—a, A young leaf of gooseberry attacked by the cluster cup fungus or rust; b, a young fruit swollen, distorted and yellow in color from the effects of the rust; c, section through part of diseased spot showing a spore producing cup (aecidium 1, and a spermagonium 2); d, mature spores (aecidio-spores), two of which are germinating. Highly magnified. (Original.)

The gooseberry rust fungus while not very destructive as a rule, is capable of doing considerable damage to foliage and fruit. It also occurs on wild species of currants to some extent. The disease manifests its presence in early summer by causing the formation of swollen places on the leaves and enlargement and distortion of the fruit. These swollen parts are readily recognized by their bright yellow to orange color and the presence of little cup-shaped pits in the surface.

These little cups give off spores at maturity as in the case of the apple rust fungus. By some this early rust stage is believed to be connected with a later one represented by *Puccinia ribis D. C.*, which corresponds to a similar spore stage of other rust fungi.

Few suggestions for treating this disease are given. While sprayed plants are less apt to show the disease in its worst form yet it has been found by the writer on plants thus treated. To be at all effectual spraying should be made early, as the fungus when once established in the tissues of its host cannot be reached by external applications. Picking and burning diseased parts has been suggested as likely to reduce the attacks for the succeeding season. The copper sulphate solution should be tried just before the buds open in spring to be followed by one of the clear fungicides after the fruit has formed.

POWDERY MILDEW.

(Sphaerotheca mors-uvae (Schw.) B. & C.)

The powdery mildew of the gooseberry and currant is widely distributed and is capable of causing considerable damage to foliage, young shoots and fruit. It may appear quite early in the season and continue for some time. Affected parts at first appear to be coated with a whitish cobweb-like growth of minute threads. These soon give rise to spore bearing stalks in abundance each minute stalk breaking up into a chain of colorless spores thus giving a powdery appearance to

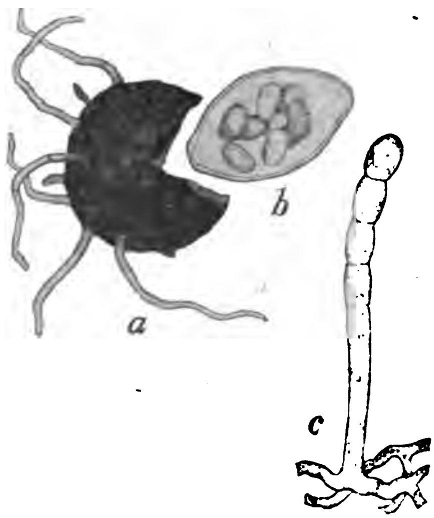

Fig. 35.—Powdery mildew gooseberry. a, A resting spore case (perithecium), discharging its single spore sac (ascus), which contains eight winter or resting spores; c, the summer spore stage of the disease, showing a spore stalk (conidiaphore), which divides, thus forming spores which soon fall apart. Magnified. (Original.)

the disease portions. While the fungus is confined to the surface of the host plant it obtains nourishment by means of minute sucker-like branches (haustoria) which enter the epidermis of affected parts. Later in the season the fungus threads darken in color and if examined with a lens will be found to have small dark bodies imbedded among them. These little specks are the resting or winter spore cases (Perithecia) of the fungus and are destined to carry the disease over to the next season. The gooseberry mildew thrives best in the warmer portions of the United States and during the hottest seasons. It has been found to be especially bad also on the foreign varieties of the gooseberry while the native sorts are less subject to its attacks.

Treatment.—As powdery mildew is an external parasite it yields quite readily to treatment. Spraying should be begun as soon as the leaves are unfolding; the first application may be of Bordeaux mixture but the potassium sulphide

solution should be used as soon as the berries are about half grown to avoid staining them.

LEAF-SPOT DISEASE. (See on Currant.)

DISEASES OF THE RASPBERRY AND BLACKBERRY.

ORANGE RUST OF RASPBERRY AND BLACKBERRY.

(Caeoma luminatum Lk.)

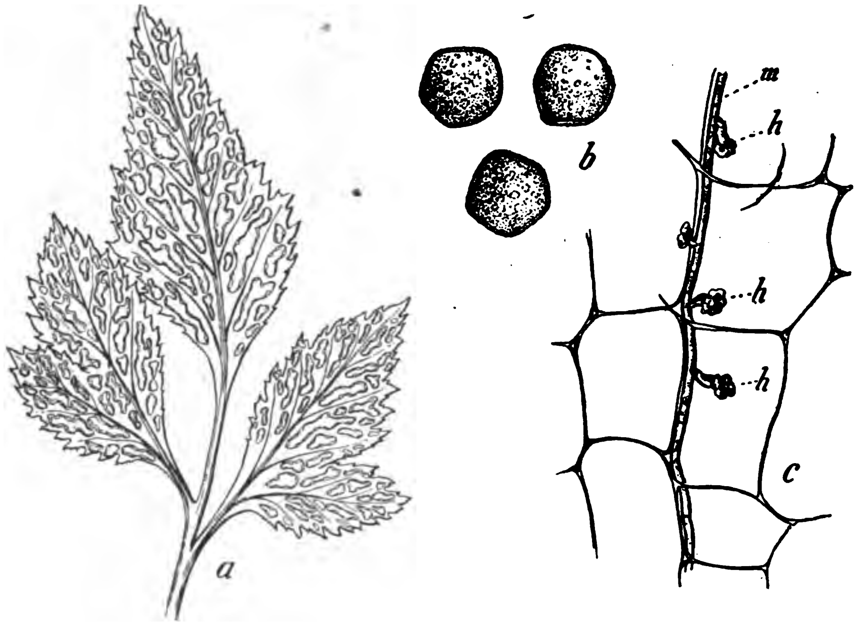

Fig. 36.—a, A small leaf of raspberry, showing blisters produced by the orange rust fungus; b, spores from a blister; c, sectional view of pith cells from diseased cane, showing a strand of mycelium m, passing between the cells and giving rise to sucker-like branches (haustoria), h, h, h, which enter the cells and absorb their nourishment. Magnified. (Original.)

The disease of the blackcap raspberries and of the blackberry, known as orange rust, is probably the most serious of the fungus diseases of these plants. The fungus possesses a perennial mycelium which lives in the pith of affected canes and even extends into the underground portions of the host plant. In the spring the leaves borne on such canes appear to be covered with small blisters of an orange yellow color which often unite in irregular zigzag lines. These blisters occur on the lower surface of the leaf and soon after their appearance the epidermis of the leaf ruptures along the center of the swellings thus allowing orange colored powdery spores to escape. These spores are capable of germinating as soon as shed and if they fall into a drop of moisture in contact with a healthy leaf of the host plant may produce an infection. After gaining an entrance into the leaf the mycelium finds its way through the leaf stalk into the pith of the cane where it lives until the next season to again grow out into new foliage. This mycelium does not enter the cells of the host plant but passes among them through the intercellular spaces sending peculiar knotted branches (haustoria) into the cells.

By some botanists the orange rust is considered to be the Aecidial stage of *Puccina Peckiana* Howe, which corresponds to the winter spore stage of the rust. The latter fungus also occurs later on the leaves of the raspberry, especially those which bore the orange rust earlier in the season.

The effects of this parasite are shown in the reduced vigor and size of diseased plants, the new growth being sickly and slender while the entire plant eventually dies. The perennial nature of the fungus enables it to appear year after year

when once it gains an entrance into the tissues of the host. Hence plants which are once attacked rarely recover. Any plant, therefore, which shows the characteristic orange colored blisters on its foliage should be dug out and burned at once else it will serve as the breeding place of the parasite. Neither should young plants be taken from among those infested with the fungus as they too will in all probability be affected. Keeping the foliage covered with some fungicide, as Bordeaux mixture early in the season will tend to prevent infection of the healthy plants.

Fig. 37.—Canes of raspberry, showing spots produced by the Anthracnose fungus. (Original.)

ANTHRACNOSE OF RASPBERRY AND BLACKBERRY.

(Gloeosporium venetum Speg.)

The anthracnose of raspberry and blackberry is a common disease of these plants and one which is capable of doing much harm. It affects the canes first, later appearing also on young shoots and leaves. The spots in the early stages of the disease are purple but as the disease progresses these spots acquire a whitish center and become somewhat sunken. In bad cases the spots run together sometimes encircling the cane; at other times they run along one side producing large patches of a grayish color. During the second season the spots tend to dry out, producing cracks in the wood and scaling of the bark.

On the leaves the spots are apt to be small but numerous and follow the general appearance of those on the canes.

The effect of this parasite is to reduce the vigor and size of all parts of the plant. The fruit often fails to mature properly but frequently dries up before ripening.

Treatment should consist of cutting out the worst diseased canes and spraying. Beginning in spring the first application may be the copper sulphate solution before the leaf buds open. The second, soon after the foliage is out, with Bordeaux mixture. A third spraying with the Bordeaux should follow the harvesting of the crop. Start new plantations from healthy canes or from root cuttings in case of red raspberry and blackberry.

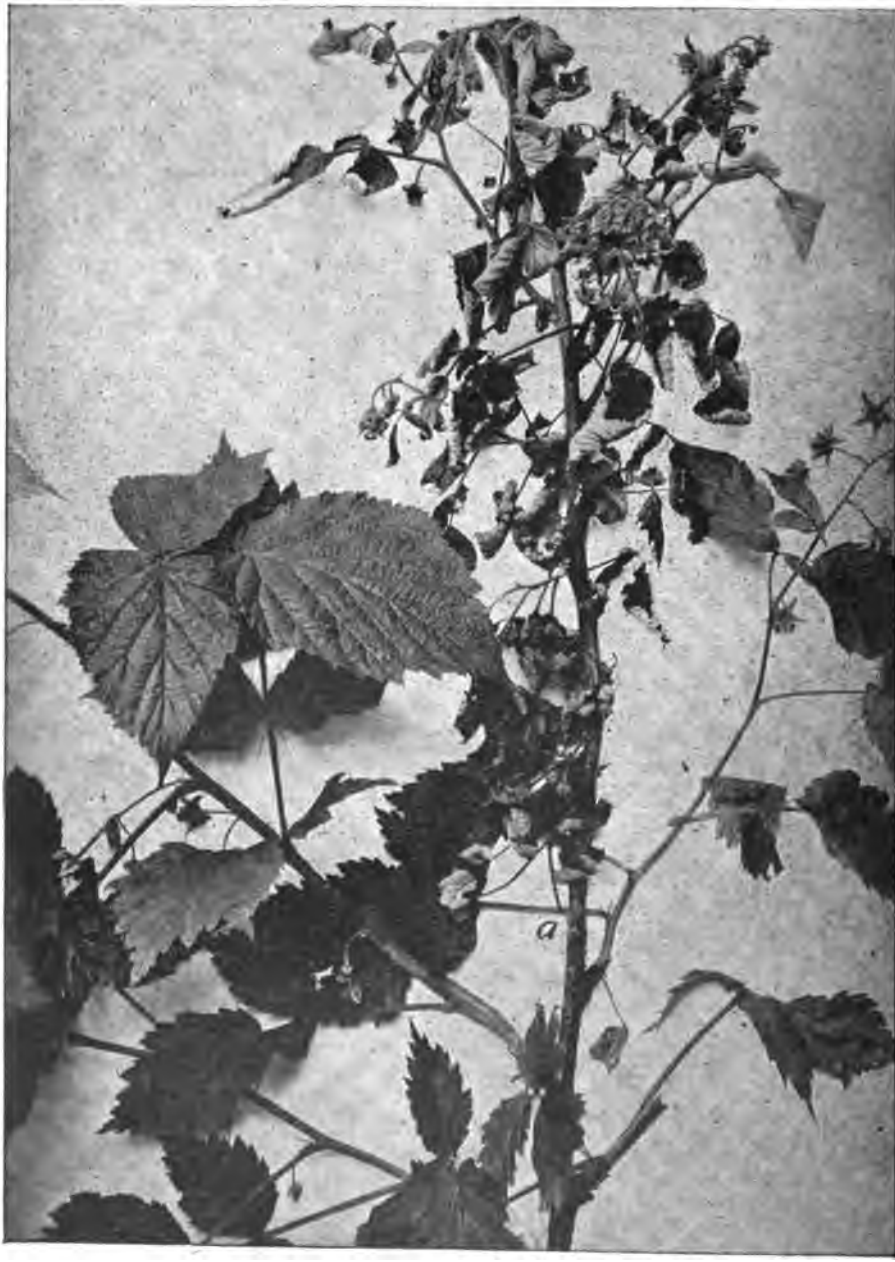

Fig. 38.—Fruiting branch of raspberry attacked by the raspberry cane blight at a. (From photo by H. J. Eustace.)

RASPBERRY CANE BLIGHT.

(Coniothyrium sp.)

This is a disease somewhat recently investigated by Stewart and Eustace in the state of New York.

During the past season (1903) the writer found the same disease occurring

not only in every plantation examined, but also on wild black raspberry plants in this state. It was especially abundant in an old raspberry patch at the Agricultural College but was found rather rarely in new plantations near the shore of Lake Michigan.

The disease attacks principally the fruiting canes, just before ripening of the fruit, and causes the death of the upper portions of the branch and in severe cases of the entire cane. The first evidence of its presence is shown by the wilting of the fruiting branches above the point affected. These soon dry up with the immature fruit still left hanging. The canes become very brittle at the diseased point while the wood is strongly discolored. The bark at these points is usually lighter colored than surrounding portions and often shows a smutty appearance due to a coating of spores. The spores are formed in minute pustules (Pycnidia) buried in the bark, from which they ooze out on to the surface of the cane. They are one-celled, egg-shaped bodies of a dark olive brown color and are believed to be the chief means by which the disease is disseminated.

All varieties of both red and black raspberries are subject to the disease, although Cuthbert is mentioned as especially subject to it and Columbian one of the least affected sorts commonly grown.

Treatment.—As yet no successful spraying measures have been found. This is possibly due to the fact that the canes do not hold any liquid substance readily, the bloom causing water to roll off, hence Bordeaux mixture does not readily adhere. Spraying the foliage does no good as the disease affects the canes only. It is recommended, however, that the old canes be cut out and burned as soon as the crop is gathered as well as all canes which show any signs of the disease. New plantations should be started from healthy canes and on soil not recently used for that purpose.

LEAF-SPOT.

(Septoria rubi Westd.)

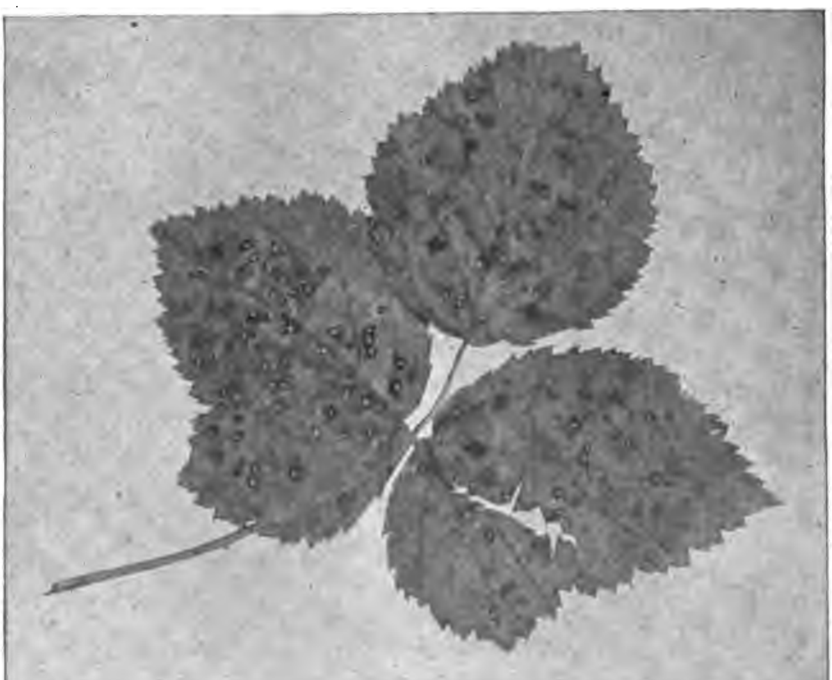

Fig. 39.—Blackberry leaf affected by the leaf spot fungus. (Original.)

The New York Experiment Station Bulletin No. 226, Geneva, N. Y.

A very common affection of the foliage of blackberry, dewberry and raspberry is the spotting due to a minute parasitic fungus called leaf-spot. The disease gives rise to numerous purplish spots which later become lighter in the center in which several small black pimples appear. These little pimples are hollow bodies which give off spores through a minute opening in the apex. The spores are slender curved bodies without color and are scattered by rain and wind.

While the leaf-spot fungus is often abundant it seems to do but little damage especially on plants that are sprayed and cultivated.

STRAWBERRY DISEASES.

LEAF-SPOT DISEASE OF STRAWBERRY.

(Sphaerella fragariae (Tul.) Sacc.)

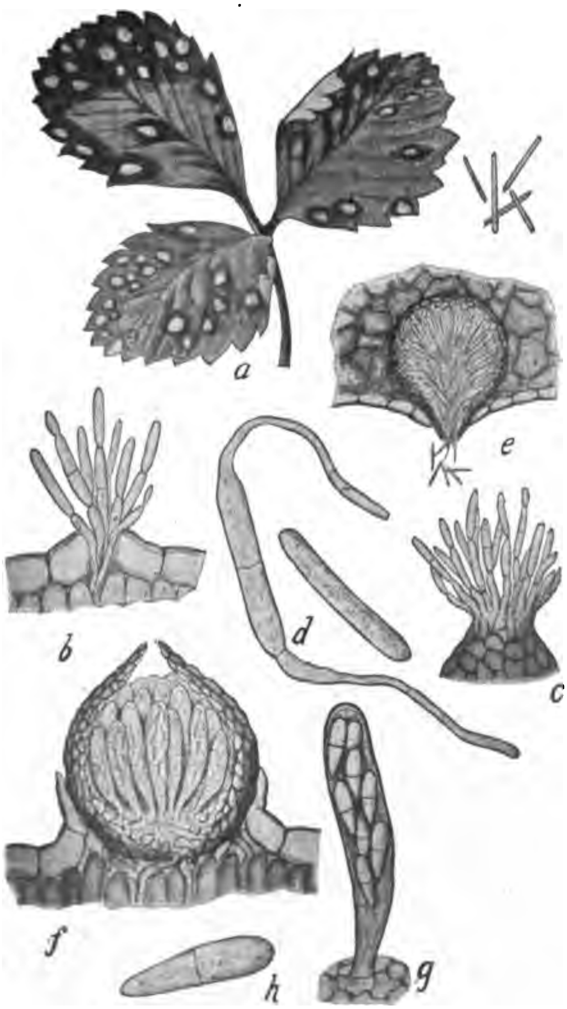

Fig. 40.—a, A leaf of strawberry affected with leaf blight; b, spore bearing tuft of mycelium bursting through the epidermis of the leaf; c, summer spores arising from apex of a resting spore case; d, summer spores (conidia), one germinating; e, section of a spore pustule (spermogonium), produced in summer; f, section of resting or winter spore case (perithecium), found in tissues of old diseased leaves which have lain on the ground over winter; g, a spore sac (ascus), containing eight two celled winter spores; h, a winter spore (ascospore), very highly magnified. (Original.)

This is the most common and important of the fungous diseases of the strawberry. It attacks the leaves causing at first purple spots which gradually become lighter in the center until they finally stand out clearly against the green background of the leaf as rounded, light colored spots surrounded with a brownish-purple border. Although these spots are not large they often run together sometimes covering a large part of the leaf. During the summer the spots give rise to minute tufts of spore-bearing stalks. The spores given off by these are capable of spreading the fungous parasite during the growing season.

Badly affected leaves die during summer and in their tissues minute, black bodies (perithecia) develop during the latter part of autumn. These bodies, which are the resting-spore cases, are situated just under the epidermis of the dead leaves but possess a projecting mouth which opens outside the leaf. On the interior of these spore cases may be seen with the microscope many very small spore sacks (asci) each containing eight two-celled spores. These spores are not mature until in spring, at which time they are capable of starting the disease on the new foliage.

Treatment should consist of spraying with some reliable fungicide, when the new foliage is appearing in spring, with a second application when fruit is setting, to be repeated after harvesting the fruit if the plantation is to be kept. Mowing and burning the leaves after the fruit is gathered, has been found to reduce this disease by destroying the old leaves in which the fungus hibernates.

WOUND FUNGI.

Among the numerous fungous inhabitants of the orchard are a number of so called wound fungi. While ordinarily existing as saprophytes, living in the dead tissues of the trees, these fungi may under favorable conditions assume the role of true parasites and cause the death of living portions of their host. As the name implies such fungi gain an entrance into the roots, trunk or limbs of a tree by means of wounds. The wounds may be of various origin, such as those caused by hail, "sun scald," splitting at the crotches from strong winds or the weight of snow, ice, or heavy crops of fruit; injuries caused by animals pastured in the orchard, and bruises made while plowing and cultivating among the trees. Improper times and methods of pruning also make it possible in a great many cases for the establishment of wound parasites. Fig. 41 shows the trunk of a tree one side of which has become inhabited by a colony of several kinds of these wound fungi. They first gained an entrance through extensive ruptures of the bark due to sun scald. The spores of these fungi, falling into the crevices thus formed, have found a favorable place to grow, and, while at first the exuding sap and dead cells of the inner bark served to nourish the young mycelium, the trunk is now being slowly invaded, the water circulation impeded or cut off in some places, and the trunk weakened by the rotting of the wood. While such trees often live and bear fruit for a number of years they gradually fall into a condition of unsightly decay and eventual death. Very often the end of a large branch which has been left too long in pruning and without a protective coating gives entrance to such fungi. In such cases the trunk is frequently hollowed out in time by the decay of the heart wood with a convenient opening left for the birds and squirrels. Such trees are apt to yield to the force of storms especially when loaded with fruit.

Most of the fungi which act as wound parasites belong to the pore-and-gill-bearing fungi, many of which are of considerable size when in fruit. The following species have been noted by the writer as occurring on trunks and limbs of fruit trees:—

Polystictus versicolor.
Polyporus adustus.
Polyporus resinosus.
Fomes leucophaeus.
Fomes igniarius.
Irpex sinuosus.
Schizophyllum commune.
Collybia velutipes.
Pholiota adiposa.
Pleurotus ostreatus.
Pleurotus areolatus.

Fig. 41.—A colony of wound fungi following an injury by sun scald on trunk of cherry tree. a, b, spore bearing organs, (sporophores) of two different fungi.

Fig. 42.—Part of branch from Keiffer pear affected with a wound fungus (Polystictus versicolor Fr.) The branch is yet alive and has produced fruit buds but the heart wood is soft and rotten. (Original.)

PREVENTIVE MEASURES.

The manner in which these fungi gain an entrance into the trunks and limbs of trees, namely through wounds, suggests the importance of treating all extensive ruptures of the bark with some protective coating. This is especially needful in the removal of large limbs. In such cases the natural process of healing over is often not accomplished for a number of years and during the process some wound fungi are pretty certain to gain a foothold unless measures are taken to exclude the spores. This is most frequently accomplished by painting or coating the cut surface with some good paint, hot tar or liquid wax. The cut should be made close to the main branch or trunk in pruning thus favoring quicker healing and avoiding stubs which die at the end and invite the attacks of these wood-destroying fungi. Lower branches which are shaded too much, as in crowded and unpruned orchards, are constantly dying back for want of nourishment. In such cases the dead portions fall a prey to wound fungi which may in time reach the main branches and trunk. Such dying limbs should be removed and the wounds covered. Where decay has begun in the trunk it is often difficult to prevent its progress. If confined to a limited portion of one side the decaying wood may be cut out as far as possible, the surface treated with a strong solution of copper sulphate and coated with tar, to be renewed as often as necessary. Removal and burning of the fungous outgrowths will also prevent the formation of spores.

INJURIES OF FRUIT TREES NOT DUE TO THE ATTACKS OF PARASITES.

Among the so called mechanical injuries of fruit trees and other plants are some of quite common occurrence. In most cases they are due to sudden changes or unusual degrees of temperature and affect mostly such plants as are not quite hardy.

"Sun Scald" is a term usually applied to injuries of the trunk and larger branches of trees arising from the killing of the inner bark and cambium by the action of the sun's rays. The south and west sides of trunks are usually affected and young trees are more subject to injury than old ones. The injury often occurs late in winter and early spring, especially when clear warm days are followed by severe cold at night and especially if growth has been prematurely started. The same trouble may arise also in summer on exposed trunks and limbs. The injury is characterized by the splitting and loosening of the bark which often becomes entirely detached. Sun scald offers a favorite place of entrance for wound fungi which sometimes cause the death of the tree. (See Fig. 41.)

"Frost Cracks" arise from the combined action of sun and severe freezing leading to longitudinal ruptures or cracks in the bark and wood. They usually occur, as does sun scald, in trees which have made a late autumn growth and which enter the winter with the tissues full of water and improperly matured. Peaches, plums and cherries, especially the sweet varieties of the latter, are more subject to these injuries than are apples and pears.

Prevention of these two injuries can be secured only by protecting the trunks from the direct rays of the sun by means of burlap, straw or other wrapping or shading devices, and by inducing the trees, so far as possible, to thoroughly mature their wood before winter sets in. The latter aim may usually be realized by the use of the proper fertilizing elements, as potash, in the soil, and especially by the use of cover crops sown late in summer, to utilize any excessive moisture which the soil may contain at this time and thus induce earlier maturity of the trees.

"Sun Scorch" of foliage is, as its name implies, due to excessive heat of the sun on foliage of plants deprived of a sufficient water supply as during a drouth. The occurrence of hot, dry winds, especially on tender foliage, also produces a similar effect. This trouble has been noted on foliage of cherry and maple trees, especially where situated on shallow soils with underlying rock. While hardly under the control of the grower the proper location of orchards accompanied with constant stirring of the surface soil to retain moisture should be considered as partial preventive means.

"Two unusual troubles of apple foliage" have been noted in New York, the first being "frost blister" and the latter the spotting of foliage caused by spraying.

The first injury was due to heavy late frosts occurring while the foliage was still very young. The damage, however, was considered unimportant, and of course beyond control.

Injury to foliage of apples by spraying was noted as quite general in New York during the summer of 1902. The foliage appeared spotted and yellowed and eventually fell off. The trouble was not considered as due to the use of improper spraying materials so much as to the tender condition of the foliage during that season induced by the protracted cold, wet weather.

Occasional injuries of this nature should point to the use of proper care in spraying methods and not to the abandonment of spraying.

SPRAYING AND SPRAY MATERIALS.

From the time of the discovery in France in 1883 that a mixture of lime and copper sulphate, applied with a whisk broom, would check the ravages of the downy mildew of the grape, to the present use of fungicides, applied with powerful pumps and perfected spraying nozzles, a long stride has been made in the prevention of plant diseases. And yet at the end of twenty years, during which a great many formulas have been devised and tested, copper in some form still retains its place at the head of the list of fungicides. Moreover the combination of copper sulphate with lime first used, and which soon became known as Bordeaux mixture, is still the most popular and widely used preparation of the copper salts.

The chief value of a spraying mixture lies in its ability to prevent the germination of the spores of the parasitic fungi causing diseases. Thus a condition of immunity is secured to the plant while it is covered with a layer of the fungicide. The salts of copper which have been found to be preeminently fungicidal owe their extensive use in this line to the fact that when they are present, even in seemingly insignificant amount the spores of fungous diseases are either prevented from germinating or killed when germination begins. Sulphur, both free and in the form of powder or in combination with other elements, is also capable of checking the action of the surface mildews for which purpose it has long been used.

In order that the best possible results may follow the use of any spraying mixture, the following conditions should be aimed at,—1. The fungicide should be the one most effective for the prevention of the disease to be combated. 2. The spraying mixture should be harmless to the foliage and other organs of the plant treated. 3. It should be applied so thoroughly as to cover the vulnerable parts of the host plant with a uniform but thin and continuous layer. 4. Mixtures used on ripening fruit should not detract from its appearance and consequent market value. 5. As a rule fungicides should not be used when the plant is in bloom.

Bordeaux mixture, as already stated, has been found to be the most effective general fungicide in use. Its value lies not alone in its immediate fungicidal property but also in the fact that the copper salt which it contains is but slowly soluble thus causing it to retain this property for a considerable period after it is applied. The materials of which it is composed are cheap and readily obtainable and its preparation, while requiring care, should not be beyond the capabilities of any fruit grower.

While Bordeaux mixture is primarily a fungicide it has also been found to possess some value as an insecticide. One of the desirable features of this mixture is the fact that it may be combined with Paris green which is the most common poison for combating leaf-eating insects. Thus two enemies may be fought with one spraying mixture. (See Bul. No. 224.)

FORMULAS.

BORDEAUX MIXTURES.

"Normal," or the 1 to 10 formula:

Copper sulphate	4 pounds
Quick lime	4 "
Water	40 gallons

The amount of water may be varied from 40 to 50 gallons, while for peaches 60 gallons of water should be used. The amount of lime may also be slightly increased, if the mixture shows a tendency to burn the foliage or roughen the fruit.

Preparation.—The copper sulphate may be dissolved by means of hot water and then diluted in the proportion of two gallons of water to one pound of salt. In preparing large amounts it is customary to place the copper sulphate in a coarse sack which is then suspended in the upper part of a barrel of water and left until dissolved.

The lime should be fresh quicklime. If this cannot be obtained double the amount of air slaked lime may be used but it is not considered so good and cannot be recommended. Slake the lime in the usual manner as in the preparation of whitewash, adding water slowly. This should then be diluted with water, after previous straining through a fine sieve or piece of coarse sacking. The two solutions are now to be mixed under constant stirring, while pouring the two liquids together, after which water is to be added to make the full amount. The more dilute the solutions are when mixed the finer will be the resulting precipitate. On the other hand, if the copper solution and the lime are concentrated, the precipitate will be coarse and heavy and is apt to clog the spraying machinery. Furthermore, the mixture when prepared with strong solutions requires more constant stirring during use to prevent settling and consequent unevenness of application. A stock solution of the copper sulphate may be made of known strength (i. e. one pound to the gallon), and kept in closed vessels and diluted when wanted. The lime may also be slaked in large amounts and if covered with water will keep for a considerable period.

The proportions of copper sulphate and lime as given, ordinarily produce a mixture which is slightly alkaline and consequently harmless to the foliage of plants. It is safest, however, to test the mixture before using it to make sure that the acid of the copper sulphate has been entirely neutralized by the lime. A reliable test consists in the use of the yellow prussiate of potash (ferrocyanide of potassium) which may be purchased at any drug store. One ounce of this salt dissolved in half a pint of water will constitute the test solution. To apply the test a little of the Bordeaux mixture is put in a white dish and a few drops of the ferro-cyanide solution added. If a brown discoloration results more of the lime milk is to be added to the mixture until the test solution remains colorless when applied. Another test consists in dipping a clean piece of polished iron or steel, as a knife blade, into the mixture for one minute, when a delicate coating of metallic copper will be deposited on the iron if there is not enough lime present. A piece of red litmus paper may also be used by dipping it into the mitxure, if it remains red more lime is necessary while if it becomes blue the mixture is alkaline and may be safely used.

BORDEAUX MIXTURE WITH PARIS GREEN.

Paris green, which is the most common material for combating the codling moth and other leaf and fruit-eating insects may be combined with Bordeaux mixture thus reducing the labor and expense in spraying for both fungi and insects. (See Mich. Exp. Sta. Bul. No. 224.) It may be used at the rate of one pound to 200 gallons of the mixture.

SODA-BORDEAUX; HYDRATE.

Babbit's Potash or Lye or Lewis' Lye—Soda	1 "pound" can
Copper sulphate	3 pounds
Lime	5 ounces
Water	30 gallons

Dissolve the copper sulphate in about five gallons of water and the soda or lye in ten or twelve gallons. Pour the soda solution into the copper solution while stirring. When about two-thirds of the lye solution has been added test with red litmus paper and cease to add any more of the alkali as soon as the paper turns blue. Then add the lime previously slaked and diluted, after which water is to be added sufficient to bring the mixture up to 30 gallons.

This fungicide was first used in 1895 by Prof. Halsted of New Jersey, who has given it subsequent trials with very satisfactory results. The small amount of lime which it contains gives it considerable advantage over the ordinary Bordeaux mixture in the ease of application and the almost total absence of any unsightly coating, hence it is adapted to use on fruits just before maturity.

Persons who use Soda-Bordeaux for the first time are advised to make a thorough test upon a small scale, with one or two plants, before the application is made general.

SODA-BORDEAUX WITH PARIS GREEN.

It has been satisfactorily demonstrated that Paris green may be combined with Soda-Bordeaux even to the extent of one pound to one hundred gallons, "a much higher percentage than is usually employed," without harmful effects on foliage.

COPPER SULPHATE SOLUTIONS.

(STRONG)

A.	Copper Sulphate	1 pound
	Water	25 gallons

This strong solution is for use on trees and shrubs before the leaf buds open in spring. After the leaves appear it should not be used as the foliage would be killed by it.

(WEAK)

B.	Copper Sulphate	1 pound
	Water	250 gallons
C.	Copper Sulphate	1 pound
	Water	400 gallons

The above solutions are recommended by Professor Taft as being very serviceable and safe. No. B may be used without danger to the foliage of any except the most tender plants. For the peach and equally tender kinds the No. C solution may be used. These solutions possess the advantages of easy preparation and application and do not discolor the foliage and fruit as does the Bordeaux mixture. They may therefore be used when the fruit is maturing and in the latter part of the season when the foliage is less tender.

AMMONIACAL SOLUTION OF COPPER CARBONATE.

CUPRAM.

Copper carbonate	1 ounce
Ammonia—Enough to dissolve the copper.	
Water	12 gallons

Dissolve the copper carbonate in the ammonia with constant agitation. This may be kept for a considerable time, in stoppered bottles and when wanted diluted with the proper proportion of water as given above. The strength of ammonia as generally obtained is apt to vary considerably. The strength usually recommended is the 22° or 26° Baume. If these are used a less amount is required than that generally sold, otherwise the preparation is the same.

A modified form of the above solution may be prepared by using:

Copper Sulphate	2 pounds
Carbonate of Soda (Salsoda)	2½ pounds

Dissolve each salt in two gallons of water then mix. The copper is precipitated in the form of carbonate and if allowed to settle may be collected and dried after pouring off the water. Or enough ammonia may be added to dissolve the copper carbonate and diluted with water to 40 gallons.

Prepared in either of the above ways this solution is a clear blue liquid. It is especially suited to spraying plants which are maturing their fruit as it leaves no conspicuous stain. Besides it possesses high value as a fungicide.

This solution is not suitable for combining with Paris green and other arsenites without the addition of lime in amounts two or three times that of the poison.

NOTE.—*Neither iron, nor tin vessels should be used in preparing solutions containing salts of copper.*

POTASSIUM SULPHIDE SOLUTION.

Sulphide of Potassium (Liver of sulphur)............	1 ounce
Water	3 gallons

The sulphide dissolves readily and forms a clear solution suitable for combating the powdery mildews especially on the gooseberry. The solution should be freshly prepared before using as it does not keep well.

GENERAL SPRAYING RECOMMENDATIONS.

While treatment has been suggested in connection with the description of each disease mentioned in this bulletin, some general suggestions for spraying are here given in such form as to enable the grower to determine more readily when and how often to spray. These recommendations are intended to cover the needs of the plant in case of attack by any or all of the diseases most common to it but the grower's judgment should at all times be exercised in the matter. Thus in some cases the number of sprayings may be fewer than those here given depending upon the prevalence of the different diseases. In some cases it may be advisable to repeat a spraying at once as in the event of a heavy rain that washes the fungicide from the plant. On the other hand, if the plant is already well coated with an effective fungicide there will be nothing gained by adding more.

Fungicides and insecticides can usually be combined and applied at one operation thus reducing the labor and expense in combating both enemies. See Michigan Experiment Station Special Bulletin No. 24.)

APPLE.

1. Before buds open use copper sulphate solution A.
2. Just before blossoming use Bordeaux (with an insecticide).
3. About a week after blossoms fall, with same preparation as No. 2.
4. Ten days or two weeks later, repeat 3. (Sometimes omitted.)
5. About August 1 for late varieties, repeat No. 2.

PEAR.

Spraying recommendations for the apple may be followed; use copper sulphate solution B for last application, if necessary. Cut and burn all branches affected with twig blight as soon as it appears, cutting 6-10 inches below the diseased portion. Repeat this in autumn before leaves drop.

QUINCE.

Follow the general directions for pear, omitting, perhaps the No. 5 application.

PEACH AND APRICOT.

1. Before April 1st, copper sulphate solution A.
2. After fruit sets, Bordeaux mixture, two-thirds strength (with an insecticide).
3. Ten days or two weeks later, repeat No. 2.
4. In case of brown rot, use copper sulphate solution C.
5. Repeat No. 4 about once a week if rot continues.
6. Watch for "yellows" and "little peach," digging out and burning as soon as recognized.

PLUM.

1. Cut off and burn all black knot. Before buds open, use copper sulphate solution A.
2. When fruit has set, use Bordeaux mixture (with an insecticide).
3. About two weeks later repeat No. 2.
4. At intervals of two or three weeks, repeat No. 2, if necessary.
5. When fruit is about three-quarters grown use copper sulphate solution B.

CHERRY.

1. Follow the general directions for the plum.

GRAPE.

1. Before buds open, use copper sulphate solution A.
2. When leaves are about half grown use Bordeaux mixture (with an insect poison).
3. Ten days or two weeks later, repeat No. 2. Use potassium sulphide solution if powdery mildew appears.
4. After ten days or two weeks, repeat No. 3, if necessary.
5. When fruit approaches maturity, use a clear fungicide if needed.
6. If mildew persists, after harvesting, use Bordeaux mixture.

RASPBERRY AND BLACKBERRY.

1. Cut out canes badly affected with anthracnose and insects. Before buds open spray with copper sulphate solution A.
2. After new growth is ten or twelve inches long, use Bordeaux (with an insect poison). Dig out and burn plants showing orange rust.
3. At intervals of one to three weeks, repeat No. 2. Use a clear fungicide before fruit ripens to avoid stain.
4. After fruit is gathered remove old canes, spray with Bordeaux.

CURRANT.

1. When leaves are well out and as soon as leaf-spot appears, use soda Boardeaux or ammoniacal copper carbonate.
2. After fruit is gathered use Bordeaux.
3. If leaf-spot continues, repeat No. 2.

GOOSEBERRY.

1. Before buds open, use Bordeaux (with insecticides).
2. When fruit is formed, use potassium sulphide if mildew appears.
3. When necessary, repeat No. 2.
4. After fruit is gathered, use Bordeaux if needed.

STRAWBERRY.

1. Just before blossoming, use Bordeaux (with insecticide).
2. After fruit sets, copper sulphate solution B.
3. After harvest, if to be kept, use Bordeaux.

New plantations during first year should be given treatments No. 1 and No. 3.

SPRAYING CALENDAR.

L. R. TAFT, *Horticulturist;* C. D. SMITH, *Director.*

[Special Bulletin No. 26.]

Farmers and fruit growers are beginning to understand the importance of the use of insecticides and fungicides to preserve their crops from the attacks of insects and diseases. To supply information as to the best remedies and the methods of preparing and using them, in a form that can be preserved so as to be convenient for reference, the following bulletin has been prepared. The remedies have been thoroughly tested, and if the directions regarding their preparation and application are carefully followed, they will be found effectual and can be used without danger to the foliage and fruit, or the health of the consumer.

Explanation.—While the entire number of applications given will be found desirable in seasons when insects and fungous diseases are particularly troublesome, and in the case of varieties that are subject to attack, a smaller number will often suffice. To indicate those that are of greatest importance, italics have been used, while others, that, although seldom required, may sometimes be of value, are printed in plain type. Whenever an asterisk (*) is used, it cautions against spraying trees with poisons while they are in blossom.

Plant.	First application.	Second application.	Third application.	Fourth application.	Fifth application.
APPLE: (*Scab, codling moth, bud moth, canker worm, tent caterpillar, aphis.*)	Spray before buds start, using copper sulphate solution. *For aphis use kerosene and water mixture.*†	*After the blossoms have formed, but before they open, spry with Bordeaux mixture and Paris green.**	*Within a week after the blossoms fall, Bordeaux and Paris green.**	10-14 days later, Bordeaux and Paris green.	*Spray fall and winter varieties with Bordeaux and Paris green about the first of August.*
CABBAGE: (*Worms, aphis and flea beetle.*)	*When worms are first seen, Paris green. For flea beetles, plaster and turpentine, or tobacco dust.*	*If worms reappear repeat, if plants are not heading.*	*After heads form use hot water, pyrethrum, or saltpeter (a tablespoonful to a gallon of water).*	Repeat if worms reappear. For Aphis use kerosene and water mixture.	(NOTE.—For the oyster-shell scale on the apple, spray with lime white-wash and lye after the leaves drop.)
CHERRY: (*Rot, aphis, curculio, slug and leaf blight.*)	*Before the buds open, spray with copper sulphate; for the aphis use kerosene emulsion, or kerosene and water mixture.*†	*When the fruit has set, spray with Bordeaux mixture and Paris green.**	10-14 days later, if slugs or signs of rot appear, repeat.	10-14 days later, weak copper sulphate solution if necessary, or soda Bordeaux.	For leaf-blight use Bordeux mixture after the crop has been gathered.
CURRANT: (*Mildew, worms, borers and leaf blight.*)	*When pruning cut out all stems that contain borers. As soon as worms are found on lower and inner leaves, spray with Paris green.*†	*If worms reappear repeat, adding Bordeaux for mildew and leaf spot.*	If worms still trouble, pyrethrum or hellebore.	After fruit is picked, Bordeaux for leaf spot.	
GOOSEBERRY: (*Mildew, leaf blight and worms.*)	*As leaves open, Bordeaux and Paris green.*†	*In ten to fourteen days repeat with both.*	*10-14 days later use sulphide of potassium on English varieties.*	*10-14 days later repeat.*	If mildew persists after crop is gathered, repeat.
GRAPE: (*Rot, mildew, anthracnose, flea-beetle, and leaf-hopper.*)	Before buds burst, spray with copper sulphate solution. Add Paris green for leaf beetles.	*When first leaves are half grown, Bordeaux and Paris green. For leaf-hoppers use kerosene and water mixture.*	*When fruit is set use Bordeaux and Paris green.*	If necessary use soda Bordeaux at intervals of 10 to 14 days.	For powdery mildew use sulphide of potassium.
PEACH, APRICOT: (*Leaf-curl, curculio, mildew and rot.*)	*Before April 1, spray with copper sulphate solution.*†	*When fruit has set, use Bordeaux mixture and Paris green, two-thirds strength.*	10-14 days later repeat.	If rot appears, use weak copper sulphate solution.	Repeat if necessary.
PEAR: (*Leafblight, scab, slug and codling moth.*)	Before buds open, copper sulphate solution.†	*When the blossoms have formed, but before they open. Bordeaux and Paris green.*	*Within a week after the blossoms fall, Bordeaux and Paris green.**	Repeat in ten or twelve days, if necessary.	Use weak copper sulphate solution, or soda Bordeaux.
PLUM: *Curculio, rot, shot-hole fungus, black-knot.*)	*Cut and burn black knots whenever found. Before buds open, spray with copper sulphate solution.*†	*As soon as the blossoms have fallen, use Bordeaux mixture and Paris green.*	*10-14 days later, repeat.*	Repeat if necessary, at intervals of 15-20 days, or use soda Bordeaux.	After fruit begins to color, use weak copper sulphate solution should rot appear.
POTATO: (*Blight beetles and scab*)	*Soak seed for scab, in corrosive sublimate (two ounces to sixteen gallons of water), for ninety minutes.*	*When beetles or their larvae appear, Paris green and lime water, or Bordeaux mixture.*	*Repeat whenever necessary*	For leaf blight use Bordeaux, beginning when the plants are eight inches high.	Repeat every week or ten days, if necessary.

Plant.	First application.	Second application.	Third application.	Fourth application.	Fifth application.
QUINCE: (*Leaf and fruit spots, slugs.*)	*Before the buds open, spray with copper sulphate.*†	*When the fruit has set, Bordeaux and Paris green.*	10-12 days later, repeat.	10-20 days later, Bordeaux.	
RASPBERRY, BLACKBERRY: (*Anthracnose, rust, cricket, slug, and galls.*)	*Cut out galls, crickets and canes badly diseased with anthracnose.* Before buds open spray with copper sulphate solution.	*When new canes are one foot high, Bordeaux and Paris green.*	10-14 days later, repeat.	After crop is gathered remove old canes, thin new ones and spray with Bordeaux if necessary.	(NOTE.—If red rust appears the entire stool affected should be grubbed out and burned.)
STRAWBERRY: (*Rust and leaf eating insects.*)	*Just before the blossoms open, Bordeaux and Paris green.*	After the fruit has set use weak copper sulphate solution.	As soon as berries are harvested, Bordeaux (if to be kept longer).	(NOTE.—Young plantations should receive first and third treatments given to bearing plants.)	(After harvesting mow and burn over the bed, especially if leaf-rollers are found.)
TOMATO: (*Rot and blight.*)	*If either disease appears, Bordeaux.*	*Repeat if disease continues.*	Repeat if necessary.		

† For the San Jose Scale upon apple and other trees use the sulphur, lime and salt mixture.

FORMULAS.

BORDEAUX MIXTURE.

Copper Sulphate	4 pounds
Fresh Lime (unslaked)	4 to 6 pounds
Water	40 to 50 gallons

Care should be taken that the lime is of good quality and well burned and that it has not become air-slaked. If only a small amount is to be slaked it will be best to use boiling water, and the lime should not be allowed to become dry while slaking. When much Bordeaux is to be prepared, it is a good plan to make up stock solutions which can be mixed as required, proceeding as follows: Dissolve 40 pounds of copper sulphate in 40 gallons of water and in a box slake 40 or more pounds of lime. These can be kept for some time, but it is best not to prepare more than can be used in a week or ten days. Each gallon of the solution will contain one pound of the copper sulphate, and in preparing it for spraying, as many gallons should be used as are necessary to furnish the proper amount of copper sulphate. Thus for each 40 gallons required, 4 gallons of the solution should be placed in a barrel in which there are 16 gallons of water. An equal weight of lime, as near as can be estimated, should be placed in another barrel and 20 gallons of water added to this. After being well stirred, the lime mixture should be allowed to stand for a minute to give the coarse particles time to settle, and then the lime water should be dipped out and slowly poured into the copper sulphate solution, stirring rapidly as the lime water is poured in. The mixture is then ready for use, but as there is danger of burning tender foliage if the amount of lime is insufficient, it is well to use some simple test, such as dipping a knife blade in the mixture or adding a few drops of ferrocyanide of potassium (yellow prussiate of potash). If the amount of lime is not sufficient, copper will be deposited upon the knife blade, while the ferrocyanide of potassium will give the mixture a deep brownish-red color. More lime should be added if necessary until no discoloration is caused in either case. A slight excess of lime will do no harm and is always desirable.

The copper sulphate can be easily dissolved, if suspended in the water in a coarse sack or basket. If the lime is properly slaked and is handled as recommended, there will be little trouble from lumps, but it is always well to strain the lime-water through a sieve, such as a piece of window screening.

This is the best remedy for fungous diseases except while the trees are dormant, or as the fruit is ripening. It is especially valuable for use with Paris green and other arsenites, as it lessens the danger of their injuring the foliage and the washing effect of rains.

DUST SPRAYS.

In places where water cannot be easily obtained, and upon rough and rolling land, the dust sprays have some advantages, but, while they are easier to apply and are less expensive, they are much less effectual against fungous diseases, and hence the liquid sprays should not be abandoned where they can possibly be used. The dust sprays are of value, to supplement the liquid applications, for both broods of codling moths and for the plum curculio. For the last named insect the dust spray gives excellent results.

Formula 1.

Copper sulphate	6 pounds
Paris green	1 to 2 pounds
Lime	100 pounds

Formula 2.

Copper sulphate	6 pounds
Sulphur	10 pounds
Paris green	1 to 2 pounds
Lime	100 pounds

As will be seen, the two formulas differ only by the addition of 10 pounds of sulphur in the second. This increases its efficiency as a fungicide, especially against the surface mildews, but it adds one-third to the cost. To prepare these dust sprays dissolve the copper sulphate in four gallons of boiling water. Then take six pounds of stone lime and slake it with four gallons of hot water. When cold add the solution of copper sulphate and mix thoroughly. Then pour into a grain sack and press out the surplus water. Without allowing it to dry add this to 100 pounds of air-slaked lime and shovel it over until thoroughly mixed. Spread it out to dry and then, after adding the Paris green (and the sulphur for formula No. 2) and mixing, pass it through a fine seive to remove the lumps. Keep in a dry place until ready for use.

To be effectual the dust sprays should be used twice as many times as the liquid sprays, or six to eight times in a season upon the apple and most other fruits. If thoroughly applied the cost of the material will be fully as great as for the liquid sprays, but the labor will be less. They should be applied, if possible, in the morning while the dew is on, or soon after a rain. If to be relied upon without the use of liquid sprays they should be put on at the time of the second and third applications given in the calendar, and should be repeated at intervals of one week, or more frequently in rainy weather. As stated above, the dust sprays seem of especial value against the codling moth, curculio and the leaf-eating insects. When the fungous diseases are not troublesome Paris green can be used with lime, either dry or air slaked, for the insects that attack the various fruits and vegetables. In addition to the codling moth, tent caterpillar and canker worm on the apple, and the curculio upon the plum, peach and cherry, the slug on the pear and cherry, the currant worms upon the currant and gooseberry, potato beetles, cabbage worms and other leaf-eating insects can be successfully combatted.

The increased use of the dust sprays is advocated on account of the improvements recently made in the machines for their application. Among those on the market are several styles made by the Dust Spray Machine Co., Kansas City, Mo., Haldeman Mfg. Co., Springfield, Mo., and Leggett & Bro., 301 Pearl Street, N. Y.

Several of these firms manufacture three sizes, viz.: a small size to be carried in the hand, a larger size to be mounted upon a platform in a cart, or wagon, and a "Jumbo" size to be worked by a gasoline engine.

SODA BORDEAUX.

Concentrated Lye	1 pound
Lime	5 ounces
Copper Sulphate	3 pounds
Water	30 gallons

Dissolve the copper sulphate and lye, and slake the lime in two gallons of hot water for each; mix the lime and copper sulphate solution and after adding the lye solution dilute to 30 gallons.

This is used upon the grape for the black rot and upon other fruits just before they are ripe.

COPPER SULPHATE SOLUTION.

Copper Sulphate	1 pound
Water	25 to 50 gallons

For use before the buds open the above solution is fully as effectual as Bordeaux mixture and is easier to prepare and apply, but it should not be applied to any plant after the buds have opened. For use against the leaf curl of the peach this solution is especially desirable. If used before the middle of April a thorough application will entirely prevent the attack.

WEAK COPPER SULPHATE SOLUTION.

Copper Sulphate	1 pound
Water	150 to 300 gallons

A solution of copper sulphate of this strength can be used with safety upon nearly all plants. The stronger solution can be used upon all fruit trees except

the peach, for which a weak solution would be preferable. Although less effective than Bordeaux mixture, the weak solutions of copper sulphate may be used to advantage where it is not desirable to apply mixtures containing lime. They seem fully as effectual as the ammonia solutions and are much cheaper.

POTASSIUM SULPHIDE.

Potassium Sulphide (liver of sulphur)	3 ounces
Water	10 gallons

This solution is valuable for the gooseberry and other powdery mildews, for which it seems even more effectual than Bordeaux mixture, although its effects are less lasting. It does not discolor the fruit and is quite harmless.

KEROSENE EMULSION.

This is a well known remedy for use upon soft-bodied or scale insects that suck the sap. It is made from kerosene, water and soap, either hard or soft, or whale oil.

To one quart of water add one pint of soft or two ounces of hard soap and heat until the soap is dissolved. Add one pint of kerosene and agitate freely for from three to five minutes, or until it forms a cream-like emulsion, from which the oil does not separate upon standing. This is a stock solution and can be kept for any length of time. Before using, it should be diluted according to the condition of the trees and kinds of insects. For scale insects it is desirable to spray while the trees are dormant, after diluting this stock solution so that there will be one part of kerosene to three of water, but if it is applied for the same class of insects while the trees are in leaf, the amount of water should be at least seven or eight times as great as of the kerosene in the stock solution. At this strength it will be fatal to all soft-bodied insects and to many of the scales, while for many of the insects with soft bodies it will be found sufficiently powerful if fifteen parts of water are used to one of the kerosene.

When making the emulsion with whale oil soap, the amount of the soap will vary with the amount of water it contains. If in a semi-liquid condition, one pint will answer for a pint of the oil, while four ounces will be sufficient if it is in a solid form.

In making the emulsion care should be taken to keep the kerosene away from the fire, and a force pump should be used rather than to rely upon a spoon or paddle.

KEROSENE AND WATER MIXTURE.

Fully as good results have been secured when the kerosene has been formed into a mechanical mixture with the water as when it is emulsified. Within the last three or four years pumps for forming this mixture have been made by The Deming Co., Salem, O., and The Goulds Co., Seneca Falls, N. Y. They can be regulated to supply any proportion of oil that is desired, and do good work. The amount of oil is practically the same as when an emulsion is made, i. e., one part of oil to three of water for scale insects when the trees are dormant, seven parts of water to one of oil for the same insects when the trees are growing, and fifteen parts of water to one of oil for most of the soft-bodied, sucking insects. When applied in this way, the cost of the materials and labor of preparing them is much reduced, and, in addition to securing as good if not better results, it has been found that the danger of injuring tender foliage is lessened. Kerosene should not be used upon peach trees.

PARIS GREEN.

Paris green	1 pound
Water	100 to 200 gallons

For the destruction of insects that eat the foliage or fruit, Paris green is a valuable remedy. It can be used in water in the above proportions, the stronger mixture being used for potatoes, while for fruits it is seldom advisable to use more than 1 pound in 200 gallons of water, unless in connection with lime water or Bordeaux mixture. It is always advisable to first form a paste with a small

amount of water when preparing it for spraying. For low plants Paris green may be used in a powder form either alone or with one hundred times its weight of plaster. London purple is sometimes used in place of Paris green, but it is more apt to injure the foliage. Green arsenoid and arsenate of lead are valuable substitutes for Paris green.

WHITE ARSENIC.

As Paris green is quite expensive and is sometimes adulterated, white arsenic is frequently used in its place. Its cost is about one-third that of Paris green, and, as it is nearly twice as effective, the expense is only one-sixth as much as when Paris green is used. To prepare arsenic for use the following treatment is necessary: In two gallons of water place two pounds of freshly slaked lime and one pound of arsenic; after boiling thirty to forty minutes the arsenic will have dissolved and united with the lime, so as to form an insoluble compound. When desired for use the arsenic should be diluted, and one pound prepared as above will suffice for two to three hundred gallons when used upon fruit trees, or one hundred fifty gallons for spraying potatoes. That there may be no injury to the foliage, it is desirable to use the arsenic thus prepared either with Bordeaux mixture or lime water. When lime water is used, one pound of lime will be sufficient for twenty gallons of water. Although the spraying calendar does not refer to arsenic, it can be substituted for Paris green if desired.

LIME, SULPHUR AND SALT MIXTURE.

Lime (unslaked)	25 pounds
Flowers of Sulphur	15 pounds
Salt	8 pounds
Water	50 gallons

The best results are secured if this mixture is cooked from 1½ to 2 hours. This can be done in a kettle but it will be much easier if steam can be secured. For small quantities place ten or fifteen gallons of water in an iron kettle holding at least twice that quantity; when it boils add the lime and then put in the sulphur. This should either be sifted in slowly or made into a thin paste and poured in, stirring the mixture at the same time. If likely to boil over add more water. The stirring should be kept up until the lime is all slaked and the sulphur has been added, then boil for at least one hour and then add the salt, and continue the boiling for fifteen minutes. This mixture should only be used while the trees are dormant.

Large amounts should be prepared in the same way but steam should be used for the cooking if possible.

If the spraying has to be done after the buds start, the salt should be omitted and four pounds of sulphate of copper should be used in its place.

The labor of preparing the mixture can be lessened and fairly good results secured without cooking the sulphur and lime. The sulphur and lime should be prepared as directed above, but omit the cooking and add four pounds of caustic soda instead of the eight pounds of salt. Stir the mixture briskly, while adding the sulphur and the soda.

When ready for use dilute to fifty gallons with warm water.

HELLEBORE.

Fresh White Hellebore	1 ounce
Water	5 gallons

For insects that chew, and especially for the currant and cabbage worms.

PYRETHRUM OR BUHACH.

Pure fresh Pyrethrum	1 ounce
Water	5 gallons

Valuable against both chewing and sucking insects, especially upon maturing fruits or vegetables, and upon flowering plants. It can also be applied in a powder form with a bellows.

CAUTIONS.

The copper solutions should be made in wood, glass or earthen vessels, and should not be prepared in iron or tin.

Care should be taken against spraying plants of any kind with lime or poisonous mixtures within four or five weeks of the time they are to be used as food.

Study carefully the nature of the insect or disease and select the remedy that is most likely to destroy it without injuring the plants.

Do not spray while the trees are in blossom, as the bees will be destroyed; they are necessary to fertilize the flowers.

Pumps for the application of insecticides and fungicides should be sufficiently powerful to cover the trees or plants with a fine mist, and where copper compounds are to be used, the working parts should be of brass, and if all portions that are to come in contact with the spraying mixture are of brass, the durability of the pump will be greatly increased, except when the sulphur, lime and salt wash is used. For this an iron pump is better. It should have metal valves and should be rinsed out each day when through spraying.

REPORT OF THE SOUTH HAVEN SUB-STATION FOR 1903.

BY T. A. FARRAND.

[Special Bulletin No. 27.]

Prof. L. R. Taft, Horticulturist:

Sir—The following report upon the work of the South Haven substation for the year 1903 is herewith submitted.

The past season was a very favorable one for nearly all classes of fruit. European plums bore very heavily, and cherries, apples and pears gave a good average yield, with a light crop of peaches, quinces and Japan plums. Of the bush fruits, gooseberries, blackberries and newer settings of raspberries made the best showing. Currants gave a fair yield, while the grapes gave only a light crop.

In nearly all instances, the spraying was attended with excellent results and the fruit was usually free from fungous diseases and the work of destructive insects.

In the line of new experimentation—A "Cyclone" dust sprayer was purchased last April of the Dust Sprayer Mfg. Co., Kansas City, Mo., the object being to determine the value of lime, as a conveyor of arsenites and fungicides in controlling destructive insects and diseases, as compared with the usual liquid sprays. For this method a great saving in cost of material and in labor, with equally as good, or better, results is claimed. It was thoroughly tested on apples and pears for scab and the codling moth, and upon plums for curculio and brown rot. It was also tried upon other classes of fruit for various insect pests and diseases. The results will be given with the general notes upon the different classes of fruits.

One mixture, (No. 1.) included lye, sulphur, copper sulphate and paris green. In preparing it a barrel of fresh lime, two and one-half pounds of common, or crude potash, twenty-four pounds of sulphur, ten pounds of copper sulphate and four pounds of paris green was used.

To prepare this material ready for the machine, one-half of the lime was spread upon the floor and the large lumps broken into pieces the size of a hen's egg, and the pile spread out to a thickness of three or four inches. This was then slaked by sprinkling it with five gallons of water in which two and one-half pounds of potash had been dissolved. The other half barrel of lime was spread out and pounded up in like manner and this was dry-slaked with five gallons of water, in which ten pounds of copper sulphate had been dissolved. After being allowed to cool, the two piles were thoroughly mixed, after which twenty-

four pounds of sulphur and four pounds of paris green were added. The whole mass was then sifted and was ready for use. In sifting it a box was used that was fifteen inches square, and five inches in depth, with a double thickness of wire window netting nailed over the end. Handles four feet long were nailed to the sides of the box to avoid being right over the box in sifting. The compound is very light and fluffy and the atmosphere becomes thick with the dust while sifting.

A thorough test was also made of dry Bordeaux mixture. In preparing this mixture, one barrel of fresh lime is dry-slaked by slowly pouring over it ten gallons of water, in which twenty pounds of copper sulphate have been dissolved, and adding four pounds of paris green, after the material has been allowed to cool, using the same method of preparing and sifting the lime as with the other formula.

A review of the season's test shows:—First, that with our method of preparing and applying the dust spray, the material was more expensive than the liquid Bordeaux, especially when sulphur was added to the compound.

Second, that the same area could be sprayed in from one-third less time with dust than with liquid, and upon very rolling, hilly locations one horse could do the work of two or three.

Third, the spraying can be done to good advantage with or against an ordinary wind using liquid as the conveyor, while with dust it cannot be used against the wind at all and the results are most satisfactory when there is little or no wind and the foliage is wet from dew or rain and in no instance did the dust stick to the foliage as well, nor stand the washings of the heavy rains as did the regular Bordeaux mixture.

Fourth, both methods gave excellent results in controlling codling moth worms in apples, and dust spraying, using formula No. 1, proved superior to Bordeaux mixture and arsenite of lime in controlling the curculio in the plum orchard, and seemed to control the brown rot fully as well. Upon very close observation it was found that the fine particles of dust would stick to the waxy bloom of the fruit while with liquid, unless very heavy with lime, the solution would run off of the plums as though they had been greased. In summing up the results obtained in this season's test, it would not seem advisable to change from the older method to the new, until the latter has been further tested, improved and perfected, except upon plums and cherries.

RASPBERRIES.

Last season a new plantation of raspberries was started, putting out only the newer, and such of the older standard kinds as proved the most valuable.

BLACK CAPS.

Cumberland, Eureka, Kansas, Livingston, Mills and Onondaga made the best showing.

Cumberland—This seems to be the best mid-season to late market kind on trial. Plant vigorous and very productive. Berries are of large size, smooth, firm, shiny, black, of good quality and hold up well in size to the end of the season.

Eureka—The plants are hardy, vigorous and productive; fruit large and retains its size well; quality good. The best early to mid-season kind on trial.

Gregg—This well-known variety is still popular as a late market variety, but does not equal the Cumberland. The berries are of lage size and very firm, but have a whitish bloom that detracts from their appearance.

Kansas—Plants vigorous and productive. Berries large; quality fair. One of the leading market varieties. A good mid-season sort for general planting.

Livingston—One of the newer kinds that has given good satisfaction during the last two seasons. Plants vigorous and productive; fruit of good size, firm and of fair quality. Ripens with Cumberland, but does not stand drouth as well.

Mills—Ripens with Livingston and the fruit resembles that variety but the plants are not as vigorous. Bore heavily this season and the fruit was of good size and held up well to the end. Berries are inclined to run small when dry weather prevails.

Onondaga—A newer variety that gave a good yield this season. Fruit large, firm and of good quality. Plants note quite so vigorous as Cumberland, with which it ripens.

RED RASPBERRIES.

Of the older varieties, Marlboro and Phoenix excelled, while Brilliant, a new variety, gave the heaviest yield, although the showing made by several other kinds of this class of fruit was very good.

Brilliant—Planted in 1901 and made an excellent showing this season. Plants hardy, vigorous and productive. Fruit large, round and a bright red in color. Moderately firm, with a mild, musky flavor. Quality low, but regardless of this its attractive appearance and productiveness make it a promising new market variety.

Coutant—A new variety received from Wiley and Sons, N. Y., in 1901, gave a good yield this season. The plant is vigorous and bushy, throwing out many laterals. The fruit is of the largest size; roundish oblate in form and quality good. Pips large, irregular and inclined to be crumbly. Ripens with Church and resembles that variety. Requires further trial.

Cuthbert—The vigor, productiveness and good shipping qualities combined, make this old variety a leading market sort in many localities. It can be planted to advantage as a medium and late sort.

Early King—The earliest kind tested this season. Plants moderately vigorous and quite productive. Berries of medium size and good quality. Valuable as an early sort.

Loudon—While it has attracted a great deal of attention and has been largely planted for commercial purposes, it does not equal either Marlboro or Cuthbert. Lacking in vigor and productiveness. Suffers from the attack of root-gall

Marlboro—This well-known variety still holds first place as an early mid-season kind for either home or market. Fruit large, firm and attractive. Plant vigorous and productive.

Miller—An early ripening variety that is highly spoken of by many growers for market purposes. Plant vigorous and productive, but the fruit is inclined to run small towards the last of the season.

Phoenix—Gave a good yield of large, attractive looking berries that lasted over a long season. Plants are stiff, stocky growers, with a dark, healthy foliage. Valuable for market.

BLACKBERRIES.

The blackberries gave a good yield this season. The fruit was large, and held its size well through the fruiting season, which can be attributed to the plentiful supply of rain at that time. Early Harvest was the most productive of the early kinds, while Wallace excelled as a mid-season sort, and Nevada gave the heaviest yield of any of the varieties, with Minnewaski, Knox, Ohmer and Eldorado next in point of value. Piasa, Lincoln, Childs, Maxwell and Western Triumph are of but slight value. Snyder and Taylor are hardy, vigorous and productive, but the fruit is rather small to compete successfully with the larger and more attractive kinds.

Notes on Varieties.

Early Harvest—Largely grown for early market; fruit inclined to run small, but the yield was large and of good size for this variety.

Early King—Ripens with Early Harvest, but while not quite so productive as that variety, it excels it in size of fruit and for this reason would seem to be the more desirable of the two.

Erie—Fruit large and attractive. Plant vigorous and hardy but only moderately productive.

Eldorado—Very hardy and productive. Ripens a few days in advance of Snyder and is superior to that variety in size and flavor. It gave a good yield this season. Fruit medium to large, firm and of very good quality.

Knox—Plant strong, vigorous and productive. Berries large, firm and of good quality. A good market variety.

Minnewaski—This variety gave the largest yield of any kind on trial last season. This year the fruit was large and attractive, but there was only an average crop. A mid-season to late ripening sort that can be safely recommended for general planting.

Mercereau—A new variety received from Wiley and Son, N. Y., in 1901. Ripens with Wallace, and resembles that variety in growth of plant and fruit. Berries large, oblong, firm and of very good quality. Requires further trial.

Nevada—This variety gave the largest yield of any kind on trial. The plants are strong and vigorous growers; quite productive; berries large, firm of good quality and rather late. One of the best.

Ohmer—A late-ripening sort that has shown considerable merit. Plant slender, spreading and fairly productive. Fruit large, firm and very good in quality.

Wallace—Very hardy, vigorous and productive. The fruit is large and retains its size well. As a mid-season variety it ranks high. It came from Wisconsin some years ago.

Wilson—Plant moderately vigorous, tender. As compared with many other varieties when grown without winter protection, it is worthless, but with a location and soil adapted to it and with proper winter protection it is one of the most profitable market varieties for many growers. It has no equal as a shipper and with its large size and attractive appearance brings the highest market price.

CURRANTS.

The currants only made a fair showing this season. Red Dutch, Wilder, London and Fay gave the largest yield of the red kinds; White Dutch excels among the white varieties, while Champion and Wales are the best of the black kinds. There is very little being done in a commercial way with black currants, although they bring a high price. This is probably due to their not being so productive as the red kinds and picking them is much slower.

Notes on Varieties.

Cherry, Fay and Select are practically alike and all are subject to the attack of the twig borer. Regardless of this, however, owing to the large size and attractive appearance of the fruit they bring the highest market price and are profitable market varieties.

London—A leading market variety. Plant hardy, vigorous and usually very productive, although the fruit does not grow quite large enough to give the most satisfactory results.

North Star—Plant a strong upright grower. Not so productive as London but the fruit runs larger. A fairly good market variety.

Pomona—A new variety that originated in Indiana and was received in 1897. Fruit is large and attractive but the plants lack vigor and productiveness.

Red Dutch—A well-known variety that generally makes a good showing. The plants are strong growers and are quite productive, but the fruit is rather small.

White Dutch—The most desirable white kind on trial. Plants vigorous and productive. Fruit of medium size and of the highest quality. An excellent variety for home use but there is no demand for white currants.

Wilder—The most promising variety on trial. Of the Cherry type in fruit, but the plants are much more vigorous and productive. The clusters are long, and ripen later than any other kind on trial. A valuable market variety.

GOOSEBERRIES.

There was a very fine crop of gooseberries on all of the standard kinds. They were all sprayed early in the spring with Bordeaux mixture and later were given a number of applications of liver of sulphur (three ounces to ten gallons of water) and no mildew made its appearance. There are a number of choice English varieties that mildew badly unless thoroughly sprayed, but when this

is done and the disease is held in check they are very profitable market varieties, as with their large size and attractive appearance they bring fancy prices. Auburn, Bendelon, Houghton, Pale Red, Smith, Strubler and Tree are undesirable here, being excelled by many varieties.

English Varieties.

Apex—A fairly good market variety, bore nearly a full crop this season. Plant a good grower, quite productive. Berries medium to large, greenish yellow, quality good.

Champion—Plant vigorous and very productive. Requires heavy pruning to get berries of good size. Gave a heavy yield of medium size fruit; quality only fair; free from mildew. A valuable market variety.

Chautauqua—This variety with Keepsake and Columbus are the best high-class market varieties of the English type that are on trial. Fruit large, oval, greenish yellow and of good quality. Plant vigorous and productive. Subject to mildew.

Columbus—Plant vigorous and productive. Berries large, roundish-oval with greenish yellow color and high quality. Bore heavily this season; valuable.

Keepsake—One of the newer English kinds that has excelled in former seasons in productiveness and gave a large yield this year. Fruit large, oval, with well-marked greenish veins. Quality very good, inclined to mildew. One of the best.

Lancashire—A very productive variety. Berries of large size and good quality, but its red color when mature is against it, as the green kinds sell much better. Otherwise a very good variety.

American Varieties.

Downing—This old, well-known variety still leads as the most profitable variety of the American kinds; vigorous and productive and the best variety for general planting.

Pearl—Ranks next to Downing as a profitable market sort. Does not equal that variety in vigor or productiveness, but the fruit runs a little larger and is of better quality. A good market variety.

Red Jacket—Plant moderately vigorous and very productive. Gave a good yield this season. Except for its red color a very good market sort.

GRAPES.

The grape crop as a whole was light this season, although a number of varieties gave a heavy yield of fine fruit. The varieties that gave the largest yield were Guinevra, Campbell, Eaton, Worden and Progress, while a good showing was made by Delaware, Diamond, Concord, Moore, Iona, Jefferson and Pocklington. No mildew and very little anthracnose made its appearance and the fruit was of very good quality.

Brighton—A large, dark red grape of high quality, ripening about the middle of September. Only moderately productive. Valuable for market, and is a very desirable kind for home use.

Campbell—This variety is making a fine record here and should be tried by all grape growers where an early market variety is desired. Of the Concord type, but it ripens ten days earlier than that variety. The vines are strong, vigorous and productive. The clusters are long, shouldered, moderately compact. Berries large, of good quality, tough-skinned and hang to the stems long after they ripen, making it a desirable variety for long distance shipping. Valuable for either home or market.

Concord—The leading market variety in Michigan. Very hardy, vigorous and productive. It has been excelled in productiveness in the station vineyard by many new varieties during the past four or five seasons, showing that location and soil conditions are important factors to the highest development of even the hardiest varieties.

Delaware—Gave a good yield this season but not so heavy as last. The most valuable red grape for home or market purposes. The reputation of this variety

for dessert purposes ensures for it double the price of the leading black kinds. In this locality the supply does not equal the demand for home consumption.

Diamond—A white grape that ripens about a week in advance of Niagara and excels that variety in productiveness. A desirable variety to plant for either home use or market. Bunches long, shouldered and compact. Quality good.

Early Ohio—This variety was received in 1900 and bore a good crop last season and a partial crop this year. Ripens with Moore and Campbell. Vines quite vigorous and appear to be productive. Clusters are of medium size, cylindrical, shouldered, quite compact. Berries small to medium, black, quality only fair. Requires further trial.

Eaton—This variety gave a very heavy yield this season. The bunches were large, of medium length, shouldered, thick, compact. Berries quite large, black, with a sprightly, vinous flavor, somewhat resembles Concord in appearance and ripens with that variety. It has lacked in productiveness some seasons but in many localities may prove a profitable variety.

Guinerva—A white grape received from C. Engle of Paw Paw, Mich. This variety gave the heaviest yield of any kind on trial this season; vines hardy, vigorous and very productive. Clusters large, compact, greenish yellow and of good quality. Ripens a few days in advance of Niagara and should be tested by growers in different localities, for it is certainly a valuable variety as grown here.

Iona—A late ripening red grape of very good quality. Productive, but inclined to ripen its fruit unevenly, and quite subject to mildew. Good for the home collection.

Jefferson—Bore a good crop this season. Ripens rather late. Clusters large, loose; color red; quality good. A long keeper, valuable for home use.

Jessica—One of the first to ripen. A small white grape of good quality and quite productive. Valuable for home use on account of its earliness.

McPike—Ripens with Concord and has the distinct flavor of that variety.

Moore—An early ripening black grape of good quality and quite productive. Clusters of medium size and compact. Berries medium large, with a very tender skin, requiring very careful handling.

Niagara—The leading white grape for home use or market.

Pocklington—A large, white grape. Bore a heavy crop of fine fruit, but has not been reliable enough in past years to be recommended.

Progress—This variety bore its first fruit in 1901 and last season made a fair showing, but in 1903 bore quite heavily; vines vigorous but rather slender. Clusters of medium size, cylindrical, shouldered and very compact. Berries small to medium-sized, with fair to good quality. Color black. Ripens with Concord and promises to be productive.

Ulster—A red grape of fine quality ripening in late September, only moderately vigorous, but very productive. Should be thinned to get annual crops and insure the ripening of the fruit. Bunches of medium size, very compact. Valuable for home planting.

Vergennes—A red grape of good quality; ripens late and keeps well. Productive here. Desirable for home use and in a small way for market.

Worden—One of the leading market varieties. A seedling of Concord. Ripens a few days in advance of that variety and excels it in quality and productiveness here. Valuable for either home or market purpose.

CHERRIES.

The cherry crop was unusually good considering the heavy frosts of April 29th and 30th, which did great damage to nearly all classes of fruit. Without doubt the proximity to the lake saved the fruit on the station grounds as the injury was much greater a mile further inland and especially in orchards situated on the lower lands. The trees blossomed very full and nearly all of the early sorts were in full bloom at the time of the frost. The sweet kinds that bore full crops were Napoleon, Early Purple, Windsor, Mary Kirtland, Cleveland and Ida, with nearly a full crop from Ohio Beauty, Gov. Wood, Plymouth, Eagle, Downer and Yellow Spanish. Of the Duke class, Montrueil, Carnation and Eugenie gave heavy

yields, while of the sour kinds Montmorency, Dyehouse, Sklanka, Suda and Ostheimer gave very heavy yields.

The fruit of the sweet varieties was very fine, and this class of fruit sold at a premium. In marketing the fruit it was noticed that the reports quoted fancy cherries with clipped stems at higher prices than when shipped in the ordinary way and for experimental purposes quite a large number of crates of clipped stems were shipped, at the same time crates of the same varieties were sent in the ordinary way. The results were that those with the clipped stems sold for from twenty-five to forty cents per crate higher than when unclipped. This is not enough to make it profitable, as there is by actual measure, two quarts more fruit in a sixteen-quart crate of clipped cherries than when unclipped. Taking into consideration the extra amount of labor and the improved appearance of the fruit, the clipped stems should bring at least from one-third to one-half more than unclipped.

The spraying was done as in former seasons, one application of copper sulphate solution, two pounds to fifty gallons of water, being given early, and two of Bordeaux mixture, and arsenite of lime within a period of twenty days after blossoms had fallen, except in a part of one block, where one tree of each variety were sprayed with dust the same number of times as with liquid as a comparison with the older method. No difference could be seen in the quality of the fruit, but when the liquid Bordeaux was used the trees held the foliage a little later in the season.

Brusseller Braune—The latest ripening variety on trial. Fruit large, dark red, flesh and juice colored. Stems long, with small leaf attached to base. Quality fine for a sour cherry, but not productive enough to be valuable for general planting.

Dyehouse—Very productive, ripens if anything a little before Richmond. Trees not so vigorous and fruit a little smaller than that variety. A good early market variety.

Lancaster—One of the newer varieties that comes in the Richmond season, but lacks the vigor and productiveness of that variety. Fruit large, color light and dark red, flesh light; juice colorless. Cannot be recommended.

Montmorency—During the past six years this variety has borne five full and one nearly full crops. No other variety on trial has this record.

Northeast—Of the English Morello type. Trees dwarfish in habit and very productive. Somewhat lacking in vigor but valuable as a late market variety. All of this type are subject to leaf blight and drop their foliage early in the season, unless thoroughly sprayed two or three times with Bordeaux mixture.

Richmond—Vigorous and productive. Well known as a profitable early market sort.

Sklanka—Ripened with Dyehouse this season and bore a full crop. Tree a more upright and thicker grower and fruit runs large, but has lacked the productiveness of that variety.

Suda—Very productive; of the English Morello type but more vigorous than any other varieties of that class. Ripens ten days later than Montmorency and is a valuable variety for common purposes. Fruit medium to large, dark red, heart-shaped. Profitable.

Wragg—Tree a slow grower, very productive, fruit large, heart-shaped, dark red, ripens late. Valuable.

DUKES.

Carnation—Bore a fine crop of fruit this season. Trees are strong, upright and spreading. Fruit large, roundish, slightly compressed, sometimes oblate; color very dark red, quite firm, quality fine. Ripens a few days in advance of Montrueil and of this class ranks next to that variety in value.

Magnifique—Tree upright, stout, moderately vigorous and productive. One of the best Dukes on trial. Fruit is large, light colored, late in ripening and of good quality. Valuable as a late ripening variety.

May Duke—An early ripening variety of fine quality. Desirable for home use, but not productive enough for market.

Montreuil—The most profitable variety in the station collection, and with Brusseller Braune bringing the highest market price. Tree moderately vigorous, very productive. Fruit large, heart-shaped, slightly compressed; color dark red,

almost black when matured. Quality fine. Ripens with Montmorency but has a longer season. Should be tried in every orchard.

SWEET CHERRIES.

Cleveland—Tree a very strong, spreading grower and productive. Fruit medium to large, compressed, slightly heart-shaped, color light yellow, shaded with red; quality fair.

Black Eagle—Tree moderately vigorous and productive. Fruit medium-sized, compressed, heart-shaped, color dark red, almost black when fully matured, quality fine. Desirable for home use.

Early Purple—The earliest ripening variety on the station grounds. Tree moderately vigorous, quite productive. Fruit medium-sized, dark red, quality good. Of no value except as protected with netting, otherwise birds take them before matured. Valuable for home use on account of earliness.

Elton—A very large, handsome cherry of fine quality. Tree quite vigorous, but has lacked productiveness.

Ida—A large, light-colored cherry of good quality. Tree fairly vigorous, very productive. Ripens with Gov. Wood but excels that variety.

Mary Kirtland—Tree moderately vigorous, very productive. Fruit medium to large, handsomely mottled with light and dark red, heart-shaped, very fine, inclined to crack when ripening, quality good. Valuable for home or market.

Napoleon—Hardy, vigorous and very productive. Fruit large to very large; color, yellow, shaded with rich red on exposed side, very firm; quality good. Has the fault of cracking open when ripening as is the case with all firm-fleshed cherries. valuable market variety.

Plymouth—This new variety is proving to be vigorous and productive. Fruit is of good quality, but is of medium size only. Ripens with Napoleon. Does not equal that variety in size or appearance.

Yellow Spanish—An old, well-known variety; hardy, vigorous and productive. Valuable for either home or market.

Windsor—The best dark-colored sweet variety under trial. Ripens soon after Napoleon and ranks next to that variety for home or market purpose. Tree vigorous and productive. Fruit large, heart-shaped, firm, dark red, almost black, quality good.

Wood—Quite largely planted for early market or home purposes. Tree vigorous and productive. Fruit medium to large, light-yellow, shaded with bright red, very tender; sometimes rots badly. Quality good. Ripe June 16th.

PLUMS.

The plum crop was very satisfactory this year, as the yield from the European varieties was unusually heavy. Varieties like Coe and Columbia that usually have been shy bearers gave heavy yields this season.

A comparative test was made with the dust spray vs. the regular Bordeaux and the arsenites. For the dust one row in the northeast block was chosen; the rest of the trees on the grounds receiving the regular spraying. Seven applications were given in all, beginning before the blossoms opened, the second within a week after the blossoms had fallen and the other five were given at intervals of a week or ten days, as seemed best. There were no Japan varieties in this test, the trees of this class being in the other blocks and these were sprayed with one-half strength Bordeaux mixture. The foliage being tender like the peach will not stand full strength. All other plum trees on the grounds received the copper sulphate solution early, and within a week after blossoms had fallen were given an application of Bordeaux mixture and arsenite of lime and three more were given at intervals of from ten to fifteen days. After the plums began to ripen, two applications of weak copper sulphate (three ounces to fifty gallons of water) were given to control the rot. Careful observation during the season showed that the injury from curculio was greater on trees where the liquid spray was used than on those treated with dust, and the latter was apparently fully as effectual in controlling the rot, although neither method of spraying kept the disease wholly in check, Lombard, Shipper and Burbank No. 7 rotting quite badly when beginning to ripen. In plum culture the brown rot is a very serious prob-

lem and it is not a question of the use of any of one method of spraying to keep it under control, but the various preventive measures should also be used. While the curculio stung a large number of plums, the crop was so heavy that the damage was very slight, and thinning was absolutely necessary with a large number of varieties, in order to save the trees from breaking down.

THINNING.

Tests of thinning to varying degrees was again practiced and the results were practically the same as obtained in 1902. The fruit was much larger and sold for a much higher price, and the thinning is one of the preventive measures in helping to control the rot. One of the points observed this season was to see if thinning would induce annual crops and from a theoretical standpoint it would seem practical, but it did not prove so with the varieties Burbank and Abundance, which set a heavy crop in 1902, when one tree of each variety was thinned when the fruit was about the size of a hickory nut, leaving them about two inches apart. The trees thinned in 1902 showed no more blooms and set no more fruit this season than the trees left unthinned. However, the commercial results obtained prove the practice of thinning to be a profitable one.

MARKETING.

In marketing the plums, the large fancy kinds sell best in four-basket tomato crates, using the one-fifth bushel basket for the smaller kinds and the sixteen-quart crate for the small Blue Damsons. This of course applies to the Chicago market. For canning factories the smaller varieties are desirable as the bulk of their products is used by hotels and restaurants by whom large numbers in a can rather than large size is preferred. For this class of trade there would be but little gain in thinning.

Notes on Varieties.—European.

Agen Prune—An old French variety of good quality. Bore a full crop this season. Has been only moderately productive in the past and the fruit is too small to make it a first-class market variety. Ripe September 1st.

Arch Duke—Gave a heavy yield this season. Fruit large, oval, black, with thick bloom; flesh rather firm, greenish-yellow, quality good. Ripens in advance of Grand Duke but is not quite so productive as that variety. Ripe August 25th.

Arctic—Tree vigorous, moderately productive in the past, and gave a good yield this season. Fruit small, dark blue, quality fair. Not valuable. Ripe August 11th.

Aubert—Resembles Yellow Egg. Tree upright, vigorous, moderately productive; gave a very heavy crop this year. Ripe August 28th.

Bavay—An old, well-known variety, very productive and of fine quality; valuable for either home or market. Ripe September 10th.

Clyman—A new variety received in 1895. Originated on the farm of Mrs. Clyman in the Napa valley, California. Tree upright, vigorous. Fruit roundish-oblong, suture well marked; stem one-half to three-fourths inches, medium stout, set in a narrow, rather deep cavity; color dark purple with bluish bloom; flesh yellow, firm, juicy, free from pit; flavor sprightly, almost sweet; quality good to very good. Ripe July 27th. Fruited for the first time last year and bore a partial crop this season. Should it prove productive it will be valuable as an early market sort.

Columbia—Late in coming into bearing. Tree vigorous, upright, spreading; bore a full crop this year. Fruit large to very large, nearly round; color purple with bluish bloom; quality fine. Ripe August 24th. Of some merit for home and market.

Czar—A medium-sized, blue plum of excellent quality but lacks in productiveness.

Black Diamond—Ripens with and is practically identical with Kingston. Tree vigorous and productive. Fruit large, blue black, handsome. One of the most profitable varieties on trial.

Dr. Uff—A prune of Hungarian origin. Received in 1893 from Division of Pomology. Two lots of scions were received, supposed to be the same variety, but they prove to be different. The first variety to ripen was medium to large;

color dark purple with a light blue bloom, form roundish-ovate, one-half usually enlarged, stem one-half inch, rather stout; cavity shallow, smooth; texture medium firm, juicy; flesh yellow, cling, quality good. Ripe August 14th. The other variety ripened August 25th, and the fruit was small to medium in size, round to roundish-oblong; color greenish-yellow with a faint, red tinge and small blotches on one side. Suture broad, well marked; stem one-half inch, medium; cavity small, smooth; texture tender; juicy; flesh greenish-yellow, very sweet, rich; free-stone; quality fine. Not attractive enough nor quite large enough to make a good market variety.

Fellenberg—Italian Prune—A very profitable variety. Tree low, very spreading, moderately vigorous; very productive. Fruit long, oval, pointed at ends, compressed; color black with thick blue bloom; flesh greenish-yellow; firm, rather juicy; quality good; excellent for preserving. Ripe last of August.

Field—Ripens with Bradshaw and resembles that variety in form, color and quality, but has not been quite as large, nor as productive in the past; gave a full crop this season.

French Damson—A valuable market variety. Has been rather late in coming into bearing. Gave a full yield this year. Fruit larger than Shropshire and fully equal for preserving purposes.

Giant Prune—A large, dark red plum of good quality. Ripened a full crop of fruit about September 1st; valuable for home or market.

Grand Duke—One of the most profitable varieties on trial. Large, handsome, very firm, ripens late, very productive.

Hungarian—Of medium size, nearly round; dark purple with thick blue bloom, very tender, juicy, quality fair. Productive, but too tender to make a desirable market variety.

Kingston—Tree vigorous and very productive. Fruit large, firm; black with a dense blue bloom, which makes it very attractive for market purposes. One of the most valuable plums.

Lincoln—Fruit large to very large; quality very good; productive and valuable for home use or nearby markets, but rather tender for long distance shipping.

Lombard—One of the most productive varieties. Fruit rots badly and the trees are subject to the attack of shot-hole fungus. Too small for fancy market unless well thinned, but well liked for canning purposes.

Lyon—Rather late in coming into bearing, but it bore a full crop this season. Tree upright, vigorous, spreading. Fruit large, round, yellow, quality good. Valuable for market if it should continue to bear well. Season middle of August.

Monarch—The most valuable late ripening variety on trial. Trees vigorous and very productive, and come into bearing early. Fruit large, dark blue, attractive. Season middle of September. Should be tried by all plum growers where this class will grow.

Moody—A large, reddish-purple plum of good quality. Ripens in early September. Productive and valuable for home and market.

Muscat Free—A new variety of the "Italian Prune" type. Received in 1894 from the Division of Pomology. Bore its first fruit last year and a full crop this season. Tree low, stocky, spreading, slow growing. Fruit medium in size, long, oval or ovate, flattened on one side. Suture broad and well-marked. Color black with thick blue bloom. Flesh moderately firm and juicy; color greenish-yellow; flavor sweet, rich; of fine quality; pit free, long, flat. Ripens a week later than Fellenburg.

Quetsche Freestone—Received from the Division of Pomology in 1894. Tree upright, quite vigorous, and promises to be productive. Fruit small to medium, oval; very firm; color black with blue bloom. Flesh yellow, juicy, sharp. Not large enough for a good market plum.

Shipper (Pride)—A medium to large, attractive looking plum. Ripens September 1st. Inclined to rot badly and lacks in productiveness.

Shropshire (Damson)—A well-known market variety. Trees productive and the fruit brings the highest price. Should be handled in sixteen-quart crates to get best results.

Spaulding—Of the Green Gage type, but ripens two weeks in advance of Bavay. Tree vigorous and quite productive. Of medium size and very good in quality.

Splendor (Prune)—Received from Stark Bros. in 1895. Bore a few fruits in 1902 and gave a half crop this year. Fruit long, oval, with neck; size medium; suture just a line; stem three-fourths to one inch, rather slender; color dark

purple with blue bloom; flesh firm, yellow and moderately juicy, sweet; quality good. Requires further trial.

Throop—Scions received from Geo. E. Ruedy, Colfax, Wash., in 1896. Fruit large, ovate, apex roundish; color dark purple; cavity deep, abrupt, smooth; flesh yellow, firm and juicy; rather coarse and stringy; flavor vinous, not rich; quality fair. Requires further trial. Ripe August 17th.

Throop No. 2—Received with Throop. One of the latest varieties under trial. Fruit large to very large, oblong, ovate, one side enlarged; color reddish-purple with thick, light blue bloom; suture broad and deep; texture firm; flesh greenish-yellow, a little coarse; flavor sweet; quality good. Bore a full crop this season and its large size and ripening season make it a promising variety.

Victoria—Of large size, attractive in appearance and good quality; very productive but very subject to rot.

Violette—A new variety that ripened fruit for the first time this season. Received from Ellwanger and Barry in 1896. Tree upright, spreading; rather a slow grower. Fruit small to medium in size; color dark purple, with a thin blue bloom; suture shallow but plainly marked. Stem medium, slender, set in a smooth, shallow cavity; flesh yellow, tender; juicy, melting, with sweet rich flavor; quality very good. Adherence semi-cling. Ripe August 25th.

Wangenheim—A medium-sized, blue, German plum of fine quality; productive and excellent for preserving purposes. Ripe late in August.

White Queen—Received from the Division of Pomology in 1890. Gave nearly a full crop this season for the first. Fruit is of large size; form roundish, ovate, flattened at base; color yellow; mottled with light red and covered with a heavy whitish bloom; suture a line; stem medium, stout, set in a shallow cavity; flesh yellow, tender, juicy, sweet, rich; fine quality; pit, cling, small, plump, oval. Season last of August. Not very desirable from the length of time taken to get into bearing.

Yellow Egg—Ripens last of August. Very large, oval, yellow, good. A fairly good market sort.

Japan Varieties.

Abundance—Largely planted for early market. An early and abundant bearer; color yellow, shaded with red; tender, juicy and of good quality. Early August.

Babcock—Ripens with Burbank, but the tree is more upright in growth. Bore a full crop this season. Fruit large, roundish-conical, sometimes heart-shaped; color dark reddish-purple when fully matured; bloom thin, purplish; flesh yellow; rather firm, juicy; flavor mild; quality only fair.

Burbank—One of the best of the Japan varieties. Tree a very strong and spreading grower; comes into bearing early and is very productive. Valuable for market.

Climax—Originated by Luther Burbank of California. Dormant budded trees were received from Wiley and Son, N. Y., in 1900, and buds were also received from Stark Bros., Mo., the same year. Fruits from both buds and tree were obtained this season. Fruit large, heart-shaped; suture distinct; cavity very deep, large; stem short, stout; color, dark red, with many yellow dots; flesh yellow, firm, moderately juicy; flavor sweet, rich, quality fine. Specimens placed on shelves in the office kept for ten days without rotting, indicating that it is a long keeper. The large size, attractive appearance, good quality and early bearing tendency affords a very promising outlook for this variety. Ripened August 8th.

Hale—Of medium size; color pale yellow, with a tinge of red on the exposed side; texture tender, juicy; flavor sweet but bitter next to skin and pit; season late August, unproductive as yet.

Ogon—Of medium size; greenish-yellow; quality low. Ripens early, moderately productive. Not valuable.

Red June—Of medium size and good quality; firm and ripens early; productive and one of the most profitable of its class.

Satsuma (Blood Plum)—Tree vigorous and productive. Fruit large and attractive; color reddish-purple with dark purple flesh; very firm, juicy. Of poor quality to eat out of hand but excellent when preserved. Valuable for either home or market.

PEACHES.

The yield of peaches was lighter this season than any year since 1899, although quite a number of varieties gave full crops of fine-looking fruit. The quality was an improvement over last year, but the season was too cold and wet to allow the devleopment of the highest flavor. As a whole, the trees did not bloom as full as usual except in the tops of the trees, there being but few live buds or blossoms on the lower branches, except upon the hardier varieties. The cold snap of February 17, 18 and 19 evidently did the most damage to the buds. The heavy frosts of April 29 and 30 and the curl leaf which was worse than it had been for years helped also in cutting the crop down to the low limit reached in the fruit belt this year. The varieties that gave full crops were Brown, Barnard, Gold Drop, Grensboro, LaFleur, Lemon Free, Longhurst, Triumph, Red Seedling and Willett, with nearly a full crop from Connett, Ford, Switzerland and Crothers.

SPRAYING.

The leaf curl was worse last spring than for many years. Reports of damage came from all sections. On the station grounds the fact was again demonstrated that thorough spraying with copper sulphate solution (2 lbs. to 50 gallons of water) will control this disease. The spraying should be done not later than the first week in April as it must be given before the buds swell. Otherwise the spraying is of no value. When the regular spraying was done, one tree each, of June Rose and Brunson, was left unsprayed to note the results. The unsprayed trees showed from fifty to sixty-five per cent of diseased leaves, against from three to five per cent on sprayed trees The varieties reported by different growers as being the worst to curl were Elberta, Lewis and Kalamazoo. The reports from many of the growers who sprayed for curl leaf were not satisfactory as only a few secured good results. Upon inquiry, some admitted that they did not spray very thoroughly, as the disease had not been very bad in the past two or three years, and others who had sprayed in former years did not spray this season for this reason. This accounts for the poor results obtained and the only safe rule in controlling the disease is to spray and spray thoroughly every year. A comparative test was made between Bordeaux mixture and copper sulphate (2 pounds to 50 gallons of water). Quite a number of fruit growers who have used both mixtures claim better results from the Bordeaux mixture than with the blue vitriol. Here the results were excellent with both materials and no difference could be seen. To determine the effects of a heavy rain within an hour after spraying for curl leaf, the barrel was rinsed out and filled with clear water and one tree each of four varieties, Bishop, Lewis, Ede and Muir was thoroughly drenched, as though there had been a heavy rain. There was no difference in the amount of curl leaf on trees drenched and those not drenched, except a very little upon the Lewis tree. These results show conclusively that the action of the copper sulphate is almost instantaneous in destroying the spores of this fungus and that a heavy rain does not destroy its fungicidal effect for leaf curl. Also, one tree each of four varieties was washed off twenty-four hours after being sprayed and no difference could be detected between the trees washed and unwashed. One tree each of the bearing varieties were sprayed with Bordeaux mixture and arsenic after the fruit had set. Very little rot made its appearance on the early varieties either on trees sprayed or unsprayed, but later in the season the rot was quite bad upon Barnard and Corner, while other varieties had very little. The thinning experiment started last season was brought to an end by the frosts as none of the varieties in the test had a sufficiently heavy crop to require thinning.

Notes on Varieties.

Advance—Received from and originated by C. Engle of Paw Paw, Mich. Of medium to large size; color white with a red cheek; quite firm; quality good. Ripe August 10th. Not sufficiently productive to be recommended; semi-cling.

Allen—Resembles Jacques Rareripe. Of large size and good quality, but less productive than that variety.

Arctic—A medium-sized, yellow freestone, ripening about the middle of September, quality poor and apparently of no value.

Bequette—Very large, white, freestone; quality fair. Ripens with Elberta and is decidedly of that type of peach in tree and fruit. Productive but not desirable on account of color.

Bickell—White, small, poor quality, late. Not valuable.

Bishop—Ripens just before and with Lewis. Bore nearly a full crop of fine looking fruit this year. Fruit creamy-white with a red cheek; quality good; freestone; productive.

Brunson—Ripens with and resembles Kalamazoo and is fully equal to that variety.

Brown—Resembles Lewis and seems even more productive than that variety. Sometimes rots badly, although free this year. Gave a heavy yield of fine fruit.

Capital—Received in 1896. Fruited for the first time in 1902 with a partial crop and gave but a light yield this season. Ripens with Smock; fruit large, oval, sometimes compressed; color yellow with faint red blush on one side; flesh yellow red at pit; tender, rather dry; quality low. Not promising.

Champion—One of the most desirable white peaches, very large, handsome; quality very good; quite productive but rather tender for long distance shipping.

Connecticut—A small, late-ripening, yellow freestone of good quality; unproductive. Not valuable.

Connett—A large, white-fleshed peach, ripening with Lewis; very productive; free from rot. One of the best of its season.

Corner—Of the Chili type in form and color, but ripens a few days earlier. Has not been a reliable bearer, but gave a good crop this year.

Crothers—A late-ripening, white-fleshed variety, of good quality and attractive appearance; a very productive and valuable white peach.

Dennis—Of small size, clear yellow, good quality. Quite productive; season early September. Not valuable.

Early Barnard—Not different from Barnard. Hardy, productive; fruit large and of good quality. A little inclined to cling to pit. Rotted worse than any other variety.

Ede—Ripens ten days earlier and resembles Elberta in form and color. Smaller than that variety and not productive enough to be valuable.

Emperor—Received from J. H. Black, New Jersey, in 1898. Ripens with it and is of the Smock type. Fruit medium-sized, oval; color yellow, with faint red blush; texture fair. Not promising. Bore only a few specimens this year.

Engle—One of the most profitable varieties on trial. It failed to yield over a half crop this year, but up to this season the trees bore three full crops of fine fruit in succession. The fruit is large, handsome, and of fine quality. Not so good a shipper as Elberta which follows it in season, but superior in other respects.

Ford—Ripens a week in advance of Lewis and although a white-fleshed peach seems of too much merit to be lost sight of. Trees hardy and very productive. Fruit large, handsomely colored and of good quality. Free from rot, semi-cling.

Ford Red—A handsomely colored, white-fleshed peach, ripening the first week in September. Productive, but coming with the yellow kinds at that time is not desirable.

Gold Drop—Very hardy and productive, inclined to overbear; quality fine. Requires heavy pruning and thinning and high cultivation; does well on the heavier soils. A valuable market variety.

Greensboro—Ripened a few days in advance of the Rivers and gave a heavy yield of exceptionally fine-looking fruit this season; texture tender; quality poor; semi-cling. Not valuable.

Husted (101)—Fruit of medium to large size and of the Chili type. Ripens with Engle, but does not equal that variety.

Jersey Yellow—Of medium size, yellow; freestone; quality poor. Ripe October 1st. Unproductive as yet.

Kalamazoo—A well-known, valuable, market variety. Trees quite productive. Fruit large, yellow with a faint cheek. Flesh light-yellow, tender and excellent in quality.

LaFleur—This variety with Longhurst and Willett made the finest showing of any varieties on trial. All are seedlings of Chili, high colored, very large,

being fully equal to Crawfords or Elbertas in size this season. LaFleur ripens a few days in advance of Longhurst and has not been quite as productive in the past.

Lemon Free—Hardy in bud, very productive. Fruit large, late, quality only fair; color clear yellow when ripened under best conditions, but greenish-yellow and rather unattractive when the weather is cold and wet, as in the past season. Considered by some a good, late market variety. Ripens about with Smock.

Lewis—A well-known market variety. Hardy and very productive. Subject to leaf curl and sometimes rots badly. One of the best sorts for early market purposes.

Longhurst—One of the hardiest in bud; very productive. A seedling of the Chili and an improvement on that variety in size. Requires heavy pruning and thinning. One of the best this season.

McCollister—A very large, handsome, yellow, freestone, ripens a few days before Smock. The trees are strong, vigorous growers and productive. Not very widely disseminated. It seems worthy of a place in every commercial orchard.

New Prolific—Bore a half crop of fine fruit this season. Fruit large, handsome, highly colored; fine quality. Ripens with Kalamazoo and Brunson.

Oceana—Of large size, attractive appearance and good quality. Bore a fair crop this year. Ripens with Engle. A good market variety.

Red Cheek—Well-known variety, large, attractive. Ripe middle of September. Moderately productive.

Red Seedling—Gave a very heavy yield this season. Fruit large, roundish; color creamy-white with handsome red cheek; flesh white, tender, juicy; quality good. Ripe August 18th.

Salway—The very best variety of its season; large, yellow with red cheek; quality good; a fine long distance shipper, and a valuable market variety. Late September.

Smock—Ripens just before Salway and is one of the valuable late market varieties. September 20.

Stevens Rareripe—Of large size, attractive appearance and good quality; flesh white. Ripens in late September. Desirable where a peach of that class is desired. Rather unproductive.

St. John—A large, fine-looking, yellow freestone peach of fine quality. Ripe August 25th. Lacks productiveness here but is considered a valuable market variety by some growers.

Switzerland—Ripens about with Stevens. White, with red cheek; smaller than that variety but more productive.

Triumph—Gave a heavy yield of large, handsome fruit this season. Rotted very little this year. Hardy in bud, vigorous and very productive. Requires heavy pruning and thinning. Considered worthless by some growers on account of its tendency to rot. The earliest yellow peach on trial.

Willett—Practically identical with Longhurst. Of the Chili type. Hardy, very productive. Fruit large, highly colored, quality good. Possibly not the true variety.

Zea—Received in 1897 from C. Engle of Paw Paw. Fruited but little as yet; fruit large, roundish-oblate; color white, overlaid with red; flesh white, tender, juicy; mild-flavored, quality poor. Ripe August 11th. Freestone. Not promising.

PEARS.

The pear crop was much lighter than last season, but the Duchess, Danas Hovey, Flemish, Giffard, Kieffer and Seckel were especially productive. The fruit was of good size and free from scab and worms. Danas Hovey, a late ripening variety of the highest quality, brought the highest price per bushel, selling in Chicago at $2.00 per bushel, with Seckel next in order at $1.75 per bushel. From all reports this was a year for growers of the Kieffer, as the crop of Bartlett and other standard varieties being light, they sold well.

The pear psylla was found working quite badly upon a few trees but by a thorough application of kerosene emulsion they were checked, using one gallon of oil and one pound of soap to fourteen gallons of water and adding one pound of pyrethrum powder to a barrel of emulsion. The dust spray was not effectual

in controlling them, and the use of kerosene emulsion became necessary. Some of the new varieties that fruited last season failed to produce any fruit this year. In spraying the pears were given the same treatment as the apples.

Notes on Varieties.

Angoulume (Duchess)—One of the most profitable varieties grown; usually on dwarf stock; very large; season late; comes into bearing early and is very productive.

Anjou—A late-ripening variety of large size and fine quality, but slow in coming into bearing. October and November.

Barry—Lacks in productiveness and is of poor quality. Fruit is large and attractive, color cinnamon russet. Season December to April.

Bartlett—Still leads as the most profitable variety grown.

Bloodgood—A fine dessert pear, ripening in early August. Of medium size; color brownish-russet, rather unattractive in appearance, but of fine quality. Productive.

Bosc—Of large size with rich golden russet skin; handsome; quality best. A valuable late fall variety.

Boussock—Of large size and fair quality; season late September. Generally quite productive.

Danas Hovey—Fruit small, obtuse-pyriform; color rich yellow-russet. Quality very best. Fully equal to Seckel in every respect, and in season one month later. Valuable.

Desportes—Size medium; color greenish-yellow, blotched with russet and a faint blush on exposed side; quality poor, unproductive. Not valuable. Season early August.

Drouard—Of medium size; yellow, sprinkled with many russet dots; form obovate, obtuse-pyriform; texture firm, breaking, granular; flavor mild, vinous, perfumed; quality fair; season December to February.

Early Duchess—Free, vigorous and very productive. Resembles Angoulume in form, color and flesh, but somewhat smaller and three weeks earlier. A valuable market variety.

Elizabeth (Manning)—Tree a handsome, vigorous grower and very productive. Fruit small, yellow, with bright red cheek; quality very good. Ripe August 15th.

Fitzwater—Size medium to large; form obvate, obtuse-pyriform; color yellow, with blotches of cinnamon russet; quality good. Season October. Of some merit for market.

Flemish—Tree vigorous and productive; fruit large and of very good quality; scabs badly unless thoroughly sprayed and is being displaced by other varieties.

Fred Clapp—Tree vigorous and productive; fruit medium to large; roundish-obovate; color yellow; quality good. October. Valuable for home or market.

Gansel Seckel—Size small to medium; unattractive in appearance; season late October. Unproductive. Not valuable.

Garber—Resembles Kieffer in fruit and growth of tree. Ripens a little in advance of and lacks much of the productiveness of that variety. Fruit soon decayed. Not promising.

Giffard—Of medium size and good quality; pyriform; color greenish-yellow with dull red cheeks. Ripens in early August and is valuable for either home use or early market.

Groveland—Ripens with and in form, color and flavor resembles Anjou. Trees lack vigor and are unproductive as yet.

Howell—A well-known, very productive and valuable market variety.

Kieffer—Tree vigorous and very productive. But little injured by blight in Michigan. Fruit attractive in appearance, but rather coarse in flesh and inferior in quality. A long keeper and shipper. Valuable.

Kentucky—Small; very poor quality. Worthless.

Kraus No. 18—Received from C. F. Kraus in 1895. Bore a half crop last year and nearly a full crop this year. Fruit large, obtuse-pyriform, color rich yellow with a handsomely striped red cheek; flavor sweet, vinous, perfumed; texture tender, melting; quality good. Ripens with Bartlett and is a promising variety.

Kraus No. 41—A medium-sized variety ripening in late August; size medium; color yellow; quality very poor. Not valuable.

Lawrence—An early winter variety of good quality. Of medium size; color yellow. Valuable for both home and market.

Lincoln—Received in 1894 from Augustine & Co, Normal, Ill. Fruited for the first time this season. Tree an upright, vigorous grower. Fruit medium-sized, obovate, obtuse, pyriform; smooth; color clear yellow; flesh white, firm, breaking; moderately juicy; flavor mild, sweet; quality fair to good. Season middle of October. Requires another trial.

Longworth—Tree vigorous and productive; quality very poor. Not valuable.

Millett—A very productive winter variety. Fruit small, unattractive in appearance and inferior in quality. Worthless.

Mt. Vernon—Size medium; color yellow, russeted; quality fair. Tree vigorous and very productive. Of value for market.

President—Very large; form roundish-obovate; color yellow, covered with russety markings and dots; flesh yellowish, rather coarse; juicy, vinous; with fair to good quality. November. Rather tardy bearer.

Reeder—Tree vigorous and quite productive. Fruit medium-sized; obtuse-pyriform; color yellow. Resembles Howell, but ripens two weeks later; quality good. Does well here.

Rostiezer—Of small size and unattractive appearance but of fine quality. Ripens in late August.

Rutter—Tree vigorous and productive. Fruit large, yellow. Quality good. Ripens middle of October. Valuable for either home or market.

Seckel—Trees compact and symmetrical. Productive of fruit of the highest quality; valuable for either home or market. A delicious dessert pear.

Sheldon—Tree vigorous but slow in coming into bearing. Fruit medium-sized; color russet. Tender, juicy, melting; fine quality.

Souvenir (du Congress)—Of the largest size; resembles Bartlett in color and flavor. Texture tender, juicy, melting; quality good. Not productive enough to be recommended for general planting. Ripe October 1st.

Sterling—A medium-sized, attractive pear, ripening in early September. Quality poor. Tree vigorous but lacks productiveness. Not valuable.

Summer Doyenne—The earliest ripening variety on trial. Only moderately productive; fruit small; quality fair. Desirable only as a very early sort.

Tyson—Tree handsome and vigorous but very late in coming into bearing. Fruit small; quality fine.

Col. Wilder—Originated by B. S. Fox, California. A young tree received in 1900, bore a full crop this year. It was received as Wilder Early, but proves to be Col. Wilder. Standard trees of this variety were received in 1896 but have failed to fruit as yet. Fruit medium to large, obtuse-pyriform; one side elongated; basin small, shallow, smooth; stalk short, stout; color, yellow, nearly covered with many small and large russet dots, with a light red cheek on exposed side; texture rather firm; only moderately juicy; granular; coarsely granular next to core; flesh whitish; flavor sweet, perfumed. Season December and January. Promising on dwarf stock.

Wilder—(Early)—Fourteen year-old trees have fruited but very little as yet, although by some growers the variety is recommended as a valuable early market sort. The trees are vigorous, upright growers; fruit medium-sized; yellow with a handsome red cheek; quality only fair. Early August.

Winter Nelis—The trees are of irregular and straggling growth; very productive. Fruit small, obovate; yellow, russeted; inferior in looks; flesh white, tender, juicy, melting; quality fine. Should be left on the tree as late as possible and stored in a cool, dark place; otherwise will shrivel instead of ripening. Valuable for home or market.

APPLES.

The apple crop was a very good one. The fruit was exceptionally fine and the spraying was attended with excellent results in controlling codling moth and scab, for which very thorough spraying was required this year. In the orchards that had not been sprayed the per cent of perfect fruit was small as compared with orchards that had been thoroughly sprayed. The apple crop along the lake shore was heavier than for years and the income from this crop alone must have been enormous to Michigan growers, but it could have been greatly increased by a thorough system of spraying. Large quantities of fruit were har-

vested this season at a profit, that would have been absolutely unsalable had the crop not been very short in many other states. Cold storage that proved unprofitable last season promises to be the opposite this year. A visit to Chicago cold storage plants in October, 1903, showed large amounts of unoccupied space, that at the same date in 1902 was filled to overflowing. The high price of barrels, and in some cases the inability to obtain them at any price, necessitated the shipping of thousands of carloads in bulk, which, although, a very satisfactory way with cider apples, can hardly be called an ideal way for handling good fruit.

SPRAYING EXPERIMENT.

Arsenite of lime has been exclusively used here in the place of paris green for several years. It is much cheaper and gives fully as good results. Quite an extensive test was made with dust as compared with liquid sprays, both on the station grounds and in a neighboring apple orchard. Formula No. 2 was used for the dust spray, and the regular Bordeaux mixture and arsenite of lime for the liquid. For winter varieties six applications of dust were given and only five of liquid. Excellent results with both methods were obtained in controlling the codling moth, but dry Bordeaux proved inferior to liquid in controlling the apple fungus. The cost of the material used in dust spraying was slightly more than for the liquid, but the cost of the labor in applying was one-third more for the liquid than the dust. The new method is practically in its infancy and while our experiments prove it to be fully equal to the older methods in some respects, we are not prepared to recommend a change until the dust spray has been more fully tested.

Notes on Varieties.

Antonovka—Origin Russia. Size large, oblate-conical; yellow; brisk sub-acid flavor. Season last of August. Unproductive.

Arnold—Large; smooth; clear yellow, very fine quality; very productive and free from scab. Valuable for either home or market. October to February.

Babbit—Large; handsomely colored; good quality; quite productive. October to December.

Bailey—Very large; sweet; color dark, rich red; very productive. October to December. A valuable market variety.

Battullen—Below medium in size; color yellow with a faint red blush; smooth, attractive; quality good. Lacks productiveness. November to February.

Ben Davis—Of large size and attractive appearance; a long keeper but of very low quality. Excelled by many in productiveness as well as quality; cannot be generally recommended for Michigan.

Bietigheimer—Of very large size and handsomely colored; quality low, unproductive. Worthless.

Bishop Bourne—Origin Nova Scotia—Received in scion from the Division of Pomology in 1895. Gave a very heavy yield this season. Of medium size; roundish, conical; color yellow; splashed and striped with red; flesh crisp, juicy, white; pleasant, quality fair. Season October to January. Promises to be very productive.

Borovinka—Resembles and ripens with Oldenburg. Fully equal to that variety.

Bottle Greening—Of large size and good quality. Tree vigorous and moderately productive. November to February.

Bough—A well-known sweet apple, ripening in August; large; yellow; fine quality; quite productive; valuable for home and for market.

Buckingham—A large apple of good appearance and fair to good quality. Season November to February. Not sufficiently productive to be recommended.

Canada Baldwin—This variety bore a very handsome crop of fine fruit this season. A seedling of Snow and has the white flesh and distinct flavor of that variety. Of medium size, roundish-oblate, striped and splashed with light and dark red; quality good. November to February.

Chenango—Tree vigorous and productive. Fruit medium to large, oblong-conical, yellow, handsomely striped and splashed with red; flesh tender, juicy; quality best. Ripe September 1st. Very tender. Requires very careful handling for market purposes.

Cogswell—An early winter variety of good quality and quite productive. Size large; color yellow, striped with red.

Cornell—Gave a full crop of handsome fruit this year; size medium; color yellow, with handsome red blush; quality good. Ripens in early September.

Decarie—Size medium to large; color greenish-yellow, nearly covered with dark, rich red and thin light grayish bloom; flesh white, tender, fine grained; flavor mild, sub-acid, aromatic; quality good. Ripe early September; unproductive as yet.

Dickinson—Tree a rather slow grower; fairly productive; fruit small but attractive in appearance; color yellow, striped and splashed with red; firm; quality fair. Season November to April.

Duchess Seedling—Large, smooth, attractive; of fair quality. Ripens a few days in advance of Oldenburg and promises to be productive.

Early Joe—A small, early ripening, red apple of fine quality; good for home use. Late August.

Fameuse—Ripened its fruit in 1902 from twelve year old trees. A valuable apple for home use and planted to some extent for market. Scabs badly.

Fameuse Sucre (Sweet Fameuse)—Roundish-oblate; dark red; fine quality; comes into bearing earlier than Fameuse. Does not seem as much inclined to scab as that variety.

Fanny—A very handsome red apple of good size and fine quality, ripening in early September. Proves to be more productive as the trees grow older. A fine dessert fruit.

Gavet Pippin—Origin Nova Scotia. Scions received in 1895 from the Division of Pomology. Fruit large, oblate; color yellow, with faint red blush; tender, fine-grained, with a mild, pleasant flavor; quality fair to good. Ripe September 15th.

Gideon—One of the hardiest and most productive varieties on trial. Fruit medium to large, yellow with handsome pink cheek; flavor brisk sub-acid; good for culinary purposes. September and early October.

Gloege—A clear yellow, long-keeping variety of only fair quality; very productive. Of some value for market.

Golden Reinette—A small striped apple with a light grayish bloom; quality fair, but too small to be valuable. Late August.

Golden Russet—At one time very popular for home and market, on account of good quality and long-keeping qualities. Has been largely replaced by other varieties; very productive here.

Golden Sweet—Of medium to large size; yellow; quality good. More productive than Sweet Bough here. Late August and early September.

Gravenstein—A valuable market variety ripening in early September. Fruit large; yellow, striped and splashed with red; flesh yellowish white, tender, crisp, juicy; quality good.

Grimes Golden—One of the leading market varieties. Fruit of medium size, roundish-oblong; color clear rich yellow; quality best; vigorous and productive. November to March.

Grosh—A medium to large, red striped apple ripening in September; of fair quality, and seems to be productive. Subject to scab; cannot be recommended.

Haas—Tree vigorous but lacks in productiveness as yet. Fruit medium-sized, red striped; quality good. Season October.

Hubbardston—Of large size, attractive appearance, good quality; very productive. A valuable winter apple for home or market.

Hurlbut—Tree a very strong, upright, spreading grower. Has been a tardy bearer but gave good yield this year. Size medium to large, red, striped; quality fair. October. Not valuable.

Indian—Of large size, attractive appearance and very productive. Fruit roundish, conical; color greenish-yellow, striped and splashed with light and dark red; quality fair. Season November to March. This variety can be safely recommended for the commercial orchard.

Iowa Keeper—Fruit small, greenish-yellow, of good quality. Productive and a long-keeper, but too small to be valuable. December to June.

Jacob—A large, red-cheeked, sweet apple of quite good quality; unproductive as yet. November to February.

Jefferis—Of medium size, handsomely colored; very good quality; quite productive. Season early September. Valuable for home use.

Jersey Sweet—A very prolific, early sweet apple of good quality; color striped red.

Jonathan—Comes into bearing early, productive. Fruit attractive and of the finest quality and commands the highest market price. Of medium size; color yellow, nearly covered with rich dark red. One of the best. November to March.

Keswick—An old variety, hardy and very productive; valuable for culinary purposes. August, September.

Kinnaird—A large, red winter apple of good quality and attractive appearance. December to March. Lacks productiveness as yet.

Limber Twig.—A small-sized, long-keeping variety of poor quality; color greenish-yellow shaded with dull red. December to April; unproductive; not valuable.

Longfield—Small to medium-sized; a very heavy bearer and very small unless thinned; color pale yellow with a red cheek; flavor sub-acid. Season September, October.

Louise—A seedling of the Snow and has the white, tender, juicy flesh, and the flavor of that variety. Size medium; color white with brownish red cheek, sprinkled with many greenish dots and specks; very productive. November to January.

Lowell—An old variety more commonly known as Gleasy Pippin. Of large size, very productive and of fine quality. Form oblong, slightly conic; color yellow. Season early September. Valuable for home use.

Maiden Blush—An old variety at one time largely planted for market. Ripens with Wealthy and not equal to that variety for market purposes.

Mason Orange—Large, roundish-oblong, tapering to the eye; color clear rich yellow, sometimes with faint red blush; quality best best; very productive; subject to scab; tender in texture and rather difficult to handle for market. November to February.

McIntosh—Of medium size; color dark rich red, with a slight bloom, giving a handsome appearance. Resembles the Snow apple in flesh and flavor; very productive and a valuable variety for market purposes. October to January.

Minkler—Size medium; color greenish-yellow, overlaid and striped with red; quality good; firm-fleshed and a long-keeper; tree vigorous and productive; valuable for market.

Morris Red—Tree an upright, close grower. Fruit resembles Hubbardston; large, handsome and of good quality. Lacks the productiveness as yet. November to February.

Mother—Of medium size, roundish-conical; color yellow, overlaid with light and dark red; flesh yellow, crisp and tender; quality fine; valuable for dessert purposes. September to December.

Munson—A medium-sized, yellow, sweet apple, ripening in September; quality good; lacks productiveness.

Nansemond—A large, attractive looking winter apple of fair to good quality; unproductive as yet; color light yellow, shaded and striped with red. November to March.

Northfield—Of large size; color yellow, blushed and faintly striped with red; unproductive.

Oakland—Of medium size; dark red with a mild, almost sweet flavor; quality good. Planted to some extent for market purposes. The tree is a slow, spreading grower, but quite productive. November to March.

Oldenburg—One of the most profitable varieties grown. Hardy, vigorous and very productive. Season late August and early September.

Ontario—This variety should be in every commercial orchard. It is a cross between the Northern Spy and Wagener and has all of the early-bearing qualities of the Wagener with the strong vigorous growth of the Spy. Color yellow, nearly covered with light red; oblate, conic, slightly ribbed; flesh whitish, crisp, tender, juicy, sub-acid; quality good. November to April.

Peter—Resembles Wealthy and practically identical with that variety; very productive; fruit medium-sized, handsomely colored; good quality. Ripe middle of September.

Pine Stump—A small, red, winter apple of good quality; very productive and a good keeper, but too small to be valuable.

Red Canada—An old, well-known, red, winter apple of attractive appearance and high quality. Tree is a slow grower and late coming into bearing, and for this reason is being replaced by other varieties.

Red Dettmer—A very showy apple ripening in early September. Lacks in productiveness. Not valuable.

Red June—A small to medium-sized, red apple of fine quality, ripening in early August. Tree moderately vigorous; very productive; valuable for home use and of some value for market.

Red Russet—Red, overlaid with cinnamon russet; medium-sized; rather unattractive in appearance; quality fair; November to March. Does not seem desirable.

Rhode Island (Greening)—An old variety largely planted for commercial purposes. There are many varieties that excel this variety in productiveness, quality and attractiveness.

Roxbury (Russet)—Old and well-known; valuable as a long keeper. Of large size, good quality, moderately productive. February to June.

Scarlet Cranberry—Size medium to large; roundish; color greenish-yellow, washed and striped with dull red; flesh firm, juicy, sprightly sub-acid; quality fair to good. December to April.

Shannon—Of very large size, greenish-yellow, very smooth and attractive; flesh tender, crisp, mild sub-acid, pleasant; quality good. December to April. Of some value for market.

Sheriff—A small, red, winter apple of good quality; very productive but rather small for market. November to March.

Shiawassee—Of the Fameuse type but larger and more productive. Comes in the season of McIntosh, but does not equal that variety in productiveness. Nevertheless a valuable variety.

Sikuli—Received in 1894 from the Division of Pomology. Size medium to large; roundish, inclining to oblate-conic; color greenish-yellow, nearly overspread with dark red; firm, crisp, moderately juicy, with a mild sub-acid flavor. December to April.

Smokehouse—Size, medium, roundish-oblate; yellow, shaded with red; flesh firm, crisp, juicy, with a sprightly sub-acid flavor; quality good. October to February. Subject to scab.

Stark—Tree vigorous and very productive. Fruit large, greenish-yellow, striped with dull red; quality fair to good. A long keeper and a valuable market variety.

Stuart—A small to medium yellow apple of good quality; moderately productive and a good keeper. November to March.

Summer Lievland—A medium-sized, reddish-yellow apple, ripening in early August; moderately productive; quality fair. Subject to scab.

Summer Pearmain—Of medium size, quality best. Lacks in productiveness here. September. Desirable for home use only.

Summer Rose—A small, early-ripening variety of excellent quality. Season middle of August. A fine dessert fruit.

Titovka—Of Russian origin and one of the most productive varieties on trial. Large, attractive; ripens a few days in advance of Oldenburg; fruit is a little coarser in texture and tree is a poorer and more spreading grower than that variety, but more productive.

Tolman—This is still the most valuable all-round winter sweet apple. Valuable for both home and market.

Townsend—An early autumn variety that is proving to be very productive. Of medium to large size; yellow, striped and splashed with red; flesh tender, moderately juicy, with mild, pleasant flavor; quality good. Season late August and early September.

Wagener—A well-known and highly prized variety. Trees lack vigor but are very productive and inclined to overbear. Fruit of large size when thinned; very smooth, free from scab; fine quality. October to February. Valuable.

Walker—Of medium size; greenish-yellow, washed and striped with dull red; smooth, handsome. Tree vigorous and proving to be very productive; flesh, white, firm, crisp, sub-acid; quality fair to good. December to April. A very promising winter variety.

Washington Strawberry—Ripens in the Gravenstein season but is much more productive than that variety here. Fruit large; oblate-conical; yellow, striped and splashed with red; flesh yellowish, crisp, tender, juicy, with a brisk sub-acid flavor. A valuable market variety.

Water—A small, yellow apple, with a handsome red cheek; crisp, juicy, sub-acid. Tree lacks vigor but is productive. November to February. Too small to be desirable.

Wealthy—Tree fairly vigorous and very productive. Fruit of medium to large size, with a handsome dark red color and good quality; commands the highest

market price for its season. September to November. The fruit is inclined to drop from the trees.

Whinnery—A medium-sized, handsome, red, winter apple. A long-keeper; very firm; quality poor; unproductive.

Winter Streifling—Tree vigorous and very productive. Fruit large, fine looking; quality rather poor. September.

Yellow Transparent—Tree vigorous and very productive; comes into bearing early. Of medium size, clear pale yellow; valuable for home or market; rather tender for long distance shipping.

York Imperial—Size medium to large; form oblate and oblique; color yellow, covered with light and dark red; very firm and crisp, with a sprightly sub-acid flavor; quality good; a good keeper. December to April. Very slow in coming into bearing. Trees thirteen years old, have fruited but little as yet.

Zolotoreff—Of Russian origin. Tree a very open grower; vigorous, but lacking the productiveness of most of this class. Fruit large, handsomely colored; rather poor quality; late August.

NEW VARIETIES.

Andrews Sweet—Origin Nova Scotia. Scions received in 1895 from Division of Pomology. Fruited for the first time this season and bore nearly a full crop. Form oblate, conical; color pale yellow; basin abrupt, deep; stem short, small, set in a small, narrow cavity; calyx nearly closed; flesh white, tender, half fine, sweet; quality good. November and December. Size small to medium.

Acker—Origin Nova Scotia. Scions received from the Division of Pomology in 1895. First fruit this year, with a good yield; size medium; form oblate, irregular; basin broad, deep; cavity broad, deep, russeted; stem medium; color yellow, striped and splashed with light and dark red and sprinkled with a few, small, light dots; texture tender, breaking, fine-grained, juicy; flesh light, tinged with red and yellow; flavor mild, sub-acid, pleasant; quality good. Season early September.

Barry (5)—Of medium size; roundish-oblate, conical; color yellow, with russety markings; firm, fine-grained, acid; poor quality. October, November.

Bath—Size medium; form oblate; basin abrupt, very deep, corrugated, cavity large, regular, rather deep; stem stout, knotty, long; color yellow overlaid with deep, rich red and sprinkled with small, to very large, greenish-yellow dots; texture firm, fine-grained, not juicy; flesh yellowish-white; flavor brisk sub-acid. Quality fair to good. Early August.

Buckskin—Small, roundish, conical; color yellow with light red blush; mild sub-acid; quality good. November to March. Not promising.

Dudley—Of large size; form roundish, oblate-conic; basin abrupt, deep, corrugated; cavity broad, deep, not smooth; stem of medium length, slender; color yellow, striped and splashed; deep rich red on exposed side, very handsomely sprinkled with many large dots; brisk, sub-acid; quality good. Ripe August 14th. Valuable if it proves productive.

Egyptian—Received in 1890. Has borne but few specimens as yet. Fruit of medium size, oblate-conic, irregular, yellow; firm, coarse-grained, sub-acid; quality good. December to April. Not valuable.

Flory (Bellflower)—Received in 1892, has fruited but little as yet. Size medium; form roundish, conical; color rich yellow. Flesh yellow; moderately juicy, sub-acid, good. October, December.

Sweet Gideon—Of medium size, roundish-oblong; yellow, striped and splashed with red; flesh white, firm, fine-grained, sweet, not rich. November to March. Grafts set in 1896, are unproductive as yet.

Glowing Coal—Ripens with and resembles Gravenstein in both tree and fruit. Of large size; roundish-oblate; yellow, overlaid, striped and splashed with red; flesh yellowish, crisp, tender, juicy, sub-acid; very good. Valuable.

Greenville—Received in 1894. A seedling of Maiden Blush. Size medium; color yellow, with red cheek; firm, crisp, juicy, fine-grained, mild, sub-acid; quality good. November to March. Unproductive as yet.

Horse—Of large size, oblate, conical; color yellow with faint tinge of red in the sun; flesh yellow, tender, juicy, crisp, sub-acid, pleasant. Middle of September. Origin, Kentucky. Received in 1895.

Hamilton Black—Received in 1895. Size medium to large, roundish-oblate;

yellow, covered with reddish-purple; flesh yellow, tender, breaking, juicy, sub-acid; quality good. September, October.

Lady Sweet—Size medium to large; oblong, conic; yellow, striped and splashed with light and dark red. Tender, fine-grained, sweet; quality, good; season November to February. A valuable sweet apple.

Magyar—Of Hungarian origin. Received from the Division of Pomology in 1894. Bore nearly a full crop this season. Size, large; oblong-conic, sometimes oblique; color yellow with a dark red blush; flesh, white; very firm with a mild, sub-acid flavor; moderately juicy. Promises to be very productive. Season January to June.

McMahon (White)—Very large; white, sometimes with faint pink blush; flesh white, very tender, fine-grained, juicy, with a sprightly sub-acid flavor; quality good; season October to December. A handsome apple which promises to be productive, but is of rather tender texture for market.

McLellan—Medium to large; color yellow, striped, mottled and splashed; form oblate, slightly conic; flesh white, tender, juicy, mild sub-acid, almost sweet; quality good. Season December to March.

Moyer (Prize)—Resembles Bellflower; size medium; form oblong-conic; color a clear, rich yellow; texture crisp, juicy; flavor sub-acid, sprightly, aromatic; quality fine. Season December to April.

Muscat (Persian)—Small; oblate-conic; yellow with faint tinge of red; flesh firm, white, fine-grained, dry, mealy, sub-acid; quality poor; early August. Not promising.

Nyack—Size medium to large; oblong-conic; yellow, shaded with crimson blush; tender, juicy, sub-acid; quality very good. Late August.

Paw Paw—A red winter apple of attractive appearance, fine quality and a long keeper. Of medium to large size; oblong, inclining to conical; texture crisp, firm, juicy; quality fine; very slow in coming into bearing; first fruit from thirteen year-old trees.

Pewaukee—Of large size; color yellow, striped, splashed and shaded with light and dark red, and covered with a light bloom; quality, firm; a good cooking apple. Season November to March.

Rainbow—Size medium; color yellow, overlaid with light red; texture dry, fine-grained, with a mild, indistinct flavor; poor quality. Last of August.

Red Gravenstein—Origin Nova Scotia. Received in 1895 from Division of Pomology. First fruit this season, a full crop. Fruit large; oblate-conic; color yellow, striped and splashed with light and dark red; flesh yellowish, crisp, tender, juicy, breaking, sprightly, sub-acid; quality good. Ripe September 1st.

Reynard—A very large yellow apple of fair quality, ripening about October 1st. Scions received from the Division of Pomology in 1895, have borne full crops the last two seasons. Its large size and productiveness would make it of some value for market.

Salome—First fruit this year from fourteen year-old trees. Fruit large; oblong-conic; yellow, overlaid and striped with light red; flesh firm, breaking, crisp, juicy; quality very good. January to June.

Scott (Winter)—Size medium; form oblate-conical; color yellow, completely overlaid and striped with light and dark rich red; very handsome; firm, fine-grained, moderately juicy, with a brisk, sub-acid flavor; quality fair; rather tardy in coming into bearing.

Shackelford—Large; oblong-conic; yellow, striped with red; crisp, tender, juicy; flavor mild, sub-acid; quality good. November to January.

Springdale—Received in 1891. A fine specimen for the first this year, of large size; form oblate; color pale yellow, washed and splashed with light and dark red; flesh very fine, breaking, juicy, mild pleasant flavor; quality good. January to May.

Summer Pegatch—Large; yellow, striped and splashed with handsome red. Flesh tender, crisp, fine-grained, moderately juicy; quality good; early September. Promising.

Summer Red—A medium-sized apple of only fair quality, ripening in September; color yellow, with a reddish-brown cheek. Not promising.

Sweet Orange—Size large; roundish, inclining to conic; color, greenish-yellow; flesh greenish-yellow, very fine-grained, sweet; quality fair to good. Season January to June; rather unattractive in appearance to take well on the market and valuable only as a long keeper.

Wall No. 1—A small, hard, red apple of poor quality. Of no value.

Westfield (Seek-No-Further)—First fruit from ten year-old trees. Of medium size; roundish-oblate-conic; color yellow, striped and splashed with light and dark red; texture crisp, fine-grained, moderately juicy, with a rich sub-acid flavor; quality very good; very productive when well into bearing.

White—Of large size, white; with very delicate pink tinge on exposed side; flesh white, tender, dry, mealy, with a vinous sub-acid flavor; quality poor. Late August.

Yellow Bellflower—An old, well-known variety, once popular and quite largely planted; of medium size, firm, crisp, juicy; brisk, sub-acid, rich, high flavor. December to March.

Zuzoff—A small to medium-sized apple, ripening in late August and early September. Form roundish-conical; color yellow, covered with very dark red; flesh white, very juicy, tender; flavor mild, vinous; quality fair to good.

Thompson No. 10—Of medium to large size; greenish-yellow, splashed and striped with red; smooth and attractive; fine, crisp, juicy, sub-acid; very productive. Ripe September 15. Valuable for market.

Thompson No. 29—A large, greenish-yellow apple, ripening about the middle of September. Promises to be very productive.

Thompson No. 28—Size, large to very large; roundish, inclining to conical; color greenish-yellow, striped and splashed with red; medium firm; crisp, juicy, sub-acid, good; last of August and early September; very productive; valuable for market if it continues to be productive.

CRAB APPLES.

There was a heavy crop of crab apples this season on nearly all varieties. For varieties ripening before September, there is but slow sale. The Hyslop leads in all market quotations; its large size and dark, rich color making it a popular market sort. The Dartmouth and Martha are also fine varieties and are the most valuable on trial.

August—Of large size for a crab; color yellow, washed and striped with red; quality fair; fairly productive. Season late August. Not valuable.

Dartmouth—Of medium size; color dark, rich, transparent red; firm, crisp, juicy; quality best. Tree vigorous and productive. Late August and early September. Will stand weeks without getting mealy. Valuable for market or home use.

Excelsior—Of large size, attractive appearance and a dessert apple. Sells for an apple rather than a crab. Tree vigorous and very productive. Fruit yellow, washed and striped with a handsome red; crisp, tender, juicy; quality very good. Late August.

Florence—Tree moderately vigorous and very productive. Fruit small, handsomely striped yellow and red; quality fair to good. Season late August. Gets mealy quickly after maturing. Not valuable.

Gibb—Large; yellow; poor quality; late August. Not valuable.

Looker—A new variety which ripened its first fruit in 1902, and bore but lightly this season. Fruit medium to large; oblong; yellow; overlaid with red and a thin light gray bloom. Flesh firm, crisp, juicy, very good quality for culinary purposes. Season late September. Ripening at this season, promising, if it proves productive.

Jelly—Small; yellow and red; quality very good for culinary purposes. Too small for market. Middle of September.

Martha—Of medium to large size; yellow, nearly overspread with bright red; very attractive; flesh crisp, tender, breaking, juicy; quality fine. Tree vigorous and very productive. Season early September. A valuable variety for either home or market.

North Star—Size small to medium; yellow, overlaid with bright red; quality medium; gets mealy very soon after maturing. Ripe August 10th. Not valuable.

No. 1 New—A seedling crab, but it should be placed with the apples. Resembles Oldenburg somewhat, but the fruit runs larger. Tree strong, vigorous and productive. Fruit large, greenish-yellow, striped and splashed with red; texture very tender; flavor brisk, sub-acid; fine for culinary purposes. Season August.

Whitney (No. 20)—Large for a crab apple; handsomely colored, fine quality for eating out of hand. Tree vigorous and productive. August. Valuable for home use.

QUINCES.

The trees bloomed very full and set a full crop of fruit, but later in the season they were attacked with fire blight, and very severe pruning was necessary in order to check the disease. A large per cent of the crop was cut off in this way. None of the varieties were wholly exempt from the attack of the blight, but Missouri, Rea and Orange were most affected, while Meech seemed to be the most resistant and gave the largest yield.

Notes on Varieties.

Alaska—Not so large as Orange, otherwise not very different from it.

Orange—Large; yellow; quality good; productive and a valuable market variety.

Meech—Of medium size; very late in ripening and does not color very well; very productive but the quality is only fair.

Missouri—Of the largest size and a good quality. The earliest ripening variety; moderately productive.

Rea (Mammoth)—Very large; yellow; fine quality; vigorous, very productive. A seedling of the Orange but a larger and finer quince than that variety.

NUTS.

All classes of nuts on trial fruited this season except the pecans and English walnuts. Paragon proved the most productive of the chestnuts, although the crop from this variety was not as large as last year. It blossomed full and set a full crop of burs, of which a large per cent failed to fill out. Of the filberts, Cosford is proving more productive than Kentish Cob.

CHESTNUTS.

AMERICAN.

Hathaway—This variety is a seedling of the native sweet chestnut and except for being a little larger, does not appear different from that class. It has borne few specimens from a tree planted in 1890 and is evidently very slow in coming into bearing.

EUROPEAN.

Comfort—Trees received in 1894 and are increasing in yield every year. While it does not equal Paragon in early-bearing qualities, it promises to be productive and the trees are handsome, vigorous growers. The nuts are, if anything, a little better in quality than Paragon and about the same in size. Ranks next to that variety.

Numbo—A very poor grower. The nuts are of large size and of good quality and are borne in smaller, thinner burs than the other varieties of this group. Bears some nuts annually but with its lack of vigor is not as desirable as either Paragon or Comfort.

Paragon—The most valuable variety on trial. The tree is a handsome grower and an early and abundant bearer; nuts of large size and good quality.

JAPANESE.

The trees of this class are very slow growers and small in size. The nuts are from medium to very large in size, and are borne in small thin burs. The quality is not so good as is that of the European kinds. They usually come into bearing very early and would also make handsome little trees for ornamental purposes.

Hale—Was received in 1899. It bore a few specimens the following year and a full crop in 1901, but failed to produce anything last season and only a few specimens this year. The nuts are of medium size, light-colored and of fair quality.

Japan Giant—Planted in 1896. The tree is a very slow grower, with a round, bushy head. Nuts are very large; quality poor; unproductive.

Japan Improved—A very slow grower and unproductive. Nuts of large size and fair quality.

Reliance—Bore very lightly this year but in past seasons has been the most productive variety of this class. Tree is a rather slow grower, forming a spreading, bushy head. Nuts of medium size and fair quality.

FILBERTS.

Cosford—Gave a full crop again this year. Tree not so vigorous as Kentish Cob but more productive. The nuts are smaller and thinner shelled, with the quality about the same as that kind. A very desirable variety for home use or ornamental purposes.

Kentish Cob—Hardy, vigorous and moderately productive. Nuts of large size and excellent quality. Desirable also to plant with Cosford as a fertilizer.

PECANS.

Seedlings received in 1890 have failed to fruit as yet. One tree set quite a number of specimens last spring but they failed to mature. The trees are handsome, thrifty growers and no doubt will mature some nuts in the next year or two.

JAPAN WALNUTS.

The trees of this species are rapid, thrifty growers and have been very productive in past seasons, but failed to give as heavy a yield as usual this season. The nuts are borne in long clusters and are quite attractive in appearance. Are smaller and in flavor are somewhat like our native butternut.

ENGLISH WALNUTS.

This class of nuts is a failure here. A number of varieties were received in the spring of 1902 from the Division of Pomology. These were grafted upon different stocks and it was hoped that in this way a hardy variety could be secured. Only two trees have survived and are not promising.

COVER CROPS.

In the report for 1902 (Bulletin No. 205), the results of a cover crop experiment in which there were eleven different plots of a quarter of an acre each were given. It was stated that oats seemed to be the ideal plant for cover-crop purposes, with barley, buckwheat, rape, winter vetch and the clovers less valuable. In all instances where the oats were sown with other kinds of seed, their value as a cover crop was increased. For instance with the vetch and clovers which do not get very high before winter comes on, the oats catch and hold the snow to a greater depth and protect the smaller plants from heaving out, at times when it is freezing and thawing. Taking into consideration the value of clovers and vetch in adding humus and plant food to the soil, as well as making a covering through the winter, a few notes were taken when the crops were turned under in May. At that time, Winter vetch, as an all-round plant for cover crop purposes was superior to anything on trial. A thick mat of six or eight inches completely covered the ground. Both Mammoth and Crimson clover made a fair showing, but the Mammoth was larger and heavier rooted than the Crimson. They also failed to grow as well under the trees as the vetch. One of the objections against clover is that the tramping in harvesting a large crop of fruit kills it out, especially in a dry time. Vetch is the most valuable plant for cover crop purposes ever tested here, but the seed is quite expensive. In plowing it under, a rolling coulter should be used, as an ordinary jointer becomes clogged and it is not possible to turn it under. The clovers were next in value. Rape is a large, coarse plant that lives

over winter and is far inferior to oats, barley, clover, vetch and buckwheat. The first frost cut the cowpeas, practically to the ground and as a cover crop for the orchard it is of but very little value unless sown early in drills and cultivated.

COOPERATIVE COVER CROP EXPERIMENT FOR WINTER OF 1903 AND 1904.

Ten plots of a quarter acre each were again sown this season on August 10th and duplicate plots were sown by Mr. Frank Warner, of Geneva township, in his peach orchard. The different kinds of seed were: Plot 1, barley, one-half bushel; plot 2, barley, one-fourth bushel and field peas, eight quarts; plot 4, oats, one-half bushel; plot 5, oats, one-quarter bushel and crimson clover two quarts; plot 6, cow peas, broadcast, ten quarts; plot 7, cow peas, drilled, five quarts; plot 8, sand vetch, eight quarts; plot 9, mammoth clover, two quarts; plot 10, crimson clover, two quarts. On December 15th the following notes were taken as to the relative merits of the different cover crops. Plots 1, 2, 3, 4 and 5 have made an excellent growth, but plots 3 and 5 are to be preferred, as they have clover sown with oats and barley, making a good low covering, with a taller growth of the other plants. There will be a good crop of clover to turn under next spring, while in plots 1 and 4, when barley and oats were used alone, there will be nothing to turn under but a light covering of straw. Plots 6 and 7, cow peas made a very poor growth and are worthless. While the cow pea is one of the leguminose plants that is capable of drawing nitrogen from the air and storing in the soil, the amount would be too small to be worth considering if planted as late as the first of August and growing only until frost comes. Plot 8, Sand vetch, has made a growth three or four inches in height, covering the ground well. Plot 9, Mammoth clover, has made a much higher, as well as thicker growth than the crimson clover. The latter point may be due to a difference in the quality of the seed sown. Plots where clover were sown alone have made a larger growth than when oats or barley was sown with it, but all things considered, it would seem best to sow oats with the clovers. There has been plenty of rain the last two seasons to ensure a good catch of any kind of seeding and what the effect would be of sowing oats or barley with the clover in an extremely dry time, has yet to be determined.

South Haven, Mich., January 11, 1904.

REPORT OF THE UPPER PENINSULA SUB-STATION.

LEO M. GEISMAR, *Superintendent;* C. D. SMITH, *Director.*

[Special Bulletin No. 28.]

WEATHER CONDITIONS.

At the close of this, the fourth year of weather observations at this station, it may perhaps be opportune to explain why three out of the four seasons have been termed as "wet," even though the total amount of precipitation is much less in the Upper Peninsula than in latitudes further south, as will be seen from the following records of average yearly precipitation at stations extending from Lake Superior to the Gulf of Mexico and at altitudes as nearly alike as possible.

Average annual precipitation at stations 1,000 to 1,150 feet elevation, the records being taken from Monthly Weather Review of the U. S. Weather Bureau and covering a period of ten years or over.

Stations.	State.	Elevation.	Precipitation.
Lathrop (Upper Peninsula)	Michigan	1,142	32.32
Grayling (Lower Peninsula)	"	1,134	33.20
Reed City (Lower Peninsula)	"	1,016	33.70
Farmland	Indiana	1,101	36.81
Rockville	"	1,100	37.45
Angola	"	1,052	38.40
Spiceland	"	1,025	39.80
Oregon	Missouri	1,113	36.12
Princeton	"	1,026	37.22
Hudson	Ohio	1,153	37.63
Canton	"	1,070	39.35
North Lewisburg	"	1,095	40.14
Mansfield	"	1,154	43.59
Mount Sterling	Kentucky	930	46.76
Lexington	"	995	44.04
Waynesboro	Tennessee	1,050	47.63
Andersonville	"	1,167	49.97
Knoxville	"	1,004	50.04
Point Peter	Georgia	1,000	50.51
Atlanta	"	1,050	52.01
Valleyhead	Alabama	1,058	56.93

These figures graphically show that precipitation increases in volume as one proceeds southward, and a more extensive list would show that this increase holds good for either higher or lower altitudes in all regions where moisture conditions are not disturbed by natural obstacles such as high mountain ranges.

Humboldt has given the following figures as the proportional quantity of rain in different latitudes:

0°	96 in.
19°	80 in.
45°	29 in.
69°	17 in.

The central part of the Upper Peninsula is in latitude 46.30 and the annual rainfall, according to Humboldt's table should be 28.25 inches, providing the great lakes were not exerting influences to raise the total rainfall above the aver-

age. The total precipitation at this station for each of the three calendar years named was as follows: 1901, 40.6 inches; 1902, 40.2 inches; 1903, 39.12 inches. The mean annual precipitation at St. Paul, the nearest important station removed from the influence of the lakes and in latitude 45°, is 27.47 inches, or about 1.5 inches less than the amount assumed by Humboldt. These figures seem to indicate that the lake influence is equal to an additional rainfall of about 11.70 inches annually.

In southern latitudes, the higher temperature induces a more rapid evaporation of the precipitated moisture, hence in northern latitudes an inch of rain will be available for a longer period for the growth and development of plants, than an inch of rain would in southern latitudes, and it is evident therefore that an annual amount of precipitation which is properly considered as excessive in northern latitudes, would in southern latitudes be considered more or less deficient with equal propriety. Furthermore, the reader should bear in mind that the soil at this station and over a considerable portion of the Upper Peninsula is relatively shallow, and though the loose rock of the upper layers of the ledge which constitutes the subsoil affords a large storage capacity for surplus water, yet the amount of rainfall which can be stored away by gravitation is necessarily smaller than in localities with a greater depth of soil. It is evident therefore, that the soil at this station will not only be at its best during so called dry seasons, but, owing to the nature of the subsoil, no vegetation is likely to suffer from lack of moisture even during a protracted drought, as long as the principles of cultivation are rigidly applied.

Winter began later than usual, the first measurable snow falling November 24, though the ground was bare again December 2. The ground for the first time was frozen to an average depth of five inches when permanent snow fell on December 3. Careful investigations on December 9 showed that the ground was entirely thawed out again, the depth of snow by that time averaging ten inches. The greatest depth of snow (26 inches) was recorded on February 18.

The spring season was backward, for while only isolated traces of snow were left on the ground April 9, it took until May 3 before they had entirely disappeared. All vegetation developed rapidly after May 15, and the usual quota of spring frosts were recorded on May 29, 30 and 31, and June 1 and 12, none except the last having caused any appreciable damage.

The summer season was abnormally cold except July and excessive rains prevailed except during June. High winds during July seriously maimed a number of fruit trees and destroyed several others, thus suggesting the necessity for windbreaks in this region when the timber is removed.

Two frosts occurred September 6 and 29, and were followed by several light and heavy frosts during October, the first killing frost, October 24. A few flakes of snow fell October 23 and 26 and November 5, and the first permanent snow fell upon unfrozen ground November 11. The following table gives the record of mean temperature and precipitation during the growing season:

Date.	May.		June.		July.		August.		September.		October.	
	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.
1	27	0	48	0	70	1.16	58	0	57.5	0	53.5	0.02
2	38.5	0.62	55.5	0	63.5	0.42	62	0.30	61.5	0.01	45.5	0
3	43	0	56.5	0	58.5	0.19	63.5	0.29	65	0.01	54	1.93
4	45	0.08	60.5	0	71	0.21	65	0	57	0	58	0.02
5	47.5	0.11	64	0	67.5	0	69.5	0.77	48	0	44.5	0.01
6	45.5	0	60	0	67	0	61.5	0.43	47	0	48	0.11
7	45	0	65	T	75.5	0	56.5	0	50	0.52	56.5	0.42
8	52	0	61	T	79.5	0	57.5	0.02	66	0.08	48.5	0.13
9	54.5	T	51	T	68	0.45	52.5	0	66.5	0	40.5	0
10	54	0.28	41.5	0.04	63	0	54	0.74	61	0	40.5	0
11	45	0.11	46	0.04	65.5	0.18	55.5	0.09	61.5	0.93	46.5	0
12	55	0.49	45	0	60.5	0	56.5	0	67.5	0	49.5	0
13	42	0	53	0	57.5	0	55	0	63	1.10	51.5	0
14	48.5	0	60	0	55	0	56.5	0	50.5	0.22	48.5	0
15	59.5	0	62.5	0	55.0	0	64	0	53.5	0.54	53	0
16	60.5	0	57.5	0.23	60.5	0	62.5	0	52	0.11	48.5	0.12
17	66.5	0	50.5	0	66	0.47	68.5	0	43.5	0.10	39	0.42
18	69	0.37	54.5	0.04	65	1.12	70.5	0.16	45.5	0.03	36	0.02
19	63	0.42	49	0	61	0.62	61	0.01	55.5	0	45	0
20	66.5	0.03	48.5	0	63	0	58.5	0	63.5	0	50.5	0
21	61	0	52	0	64.5	0.03	72	0	61.5	0	43.5	0
22	51	0	57.5	0.02	63	0	66.5	0	59.5	0	42.5	0.25
23	50	0.11	49	0.94	65.5	0	55	0	55.5	T	33	0.01
24	54.5	0	55	0.35	71	0	54	0.85	45.5	0.03	41.5	0
25	59	0.15	59.5	0	66	0.07	57.5	0.98	54.5	0	39	0
26	61.5	0.08	58	0	57	0	55.5	0	56	0.28	37.5	0.06
27	58.5	0.25	64	0	59	0	58.5	0	44.5	0.11	41.5	0
28	50	1.02	63	0.04	68.5	1.49	53	0.25	45.5	0.19	55.5	0
29	43.5	0	65	0.01	71	0.14	56	0.88	47	0	58.5	0
30	40	0	65	0	60	0.09	54.5	0.16	55.5	0.08	44	0
31	44.5	0	....	....	52.5	0	58	0	....	....	49.5	0.02
Total rainfall	....	4.12	....	1.71	....	6.64	....	5.93	....	3.34	....	3.34

SUMMARY OF RAINFALL.

May	4.12
June	1.71
July	6.64
August	5.93
September	3.34
October	3.54
Total	25.28

During the more favorable, or "dry" season of 1902, the total rainfall during the same six months was 18.29, and during 1901, a wet season, 25.28. The first season (1900) was another wet season. Observations were first taken July 8, and the total rainfall up to and including October 31 was 17.12. Taking the total rainfall for all four years from July 8 to October 31, inclusive, the figures are as follows:

1900	17.12
1901	16.40
1902	10.86
1903	17.47

FIELD CROPS.

CEREALS.

All crops, with few exceptions, stood up well and made a satisfactory showing in spite of cold and wet weather. The cereals are among the exceptions, though unfavorable weather conditions are least responsible for the failure. The immediate causes are, first, late planting; second, the most formidable invasion of grain aphis ever witnessed, and third, lack of storage room and the use of the primitive methods of hand threshing.

At the time of planting, voluntary peas from the crops of the previous season were not only sprouted but had made a growth of six to eight inches.

It becomes evident that oats and similar early grains must be planted early in this region, when a healthy growth is made by peas, and for that matter, by all other early vegetation, even before the snow has entirely disappeared, and when, as stated in a previous report, brome grass will grow unchecked while the entire ground is still covered with snow.

Owing to the dry June weather, the grain aphis multiplied at an amazing rate. They came early in June, and by the end of the month, did not seem to be materially reduced in numbers from the attacks of lady beetles and braconids. Long before the grain headed out, the leaves of oats, wheat and rye were riddled with dry spots from which the sap had been extracted by the lice, thus rendering them particularly susceptible to the attacks of rust which spread uninterrupted with the beginning of the wet July weather. It was well towards the end of July before the copious rains had succeeded in killing off an appreciable number of aphis, and the many empty oat hulls which subsequently could be seen dangling upon the grain heads remained as a silent but costly memento of the ravages of an insect which though always present, seldom multiplies sufficiently to do any great damage. The pest was evidently spread over an extensive area, judging from the numerous samples and inquiries which the stations received from many farmers

No accurate results from grain plots can be expected as long as the station is lacking in storage room and as long as the grain has to be threshed by means of the primitive hand flail. While these sortcomings are not so seriously felt during a dry season like that of 1902, they practically annul results during wet seasons like the past. Most of the grain plots were small, the largest being 1x8 rods, and all were planted between May 8 and 16.

Oats.—The straw, except for being rusty, was strong and of good size, ranging from 50 to 54 inches in length. The grain was dark colored and light, and none

of the varieties reached the standard weight, Black Beauty, the best variety, weighing 31 lbs. per bushel. Ten varieties were tested: Lincoln, American Banner, Czar of Russia, Dupauper, Black Beauty, Morgan Feller, Black Tartarian, Columbus, English Wonder and 20th Century. In yield they ranged from $13\frac{1}{8}$ bushels and 3,020 lbs. of straw per acre for English Wonder, to $21\frac{1}{4}$ bushels and 3,040 lbs. of straw for Black Beauty.

Spring Wheat.—The showing for wheat is even poorer than for oats, owing to the fact that the grain shells out most easily when handled over frequently. Furthermore, the damage from the grain aphis was severest on wheat, part of the plots being entirely killed out, and the straw when harvested, being short. The Velvet Chaff Variety remained a conspicuous exception, the straw being of a uniform height of 58 inches and the low yield being mainly due to the shelling out of the grain before it could be threshed. Of the three varieties tested, namely, Minnesota No. 163, Saskatchewan Fife and Velvet Chaff, the last gave best results, the amount of grain secured showing a yield of $13\frac{1}{5}$ bushels per acre and of 3,280 lbs of straw.

Barley.—The barleys made the best showing of any varieties of grain, with the exception of the hulless varieties which shelled out as easily as wheat, and the Canadian Thorpe, a two-rowed, bearded variety with weak straw. None of the plots were molested by aphis to any great extent, the straw remained comparatively free from rust, though the grain was light and of a grayish color. The results are shown in the following table:

Varieties.	Style.	Size of plot, rods.	Time of planting.	Headed out.	Time of harvesting.	Length of straw.	Yeild per acre.	
							Grain, bu.	Straw. lbs.
Canada 6-Rowed	Bearded	1x8	May 9	July 1	August 13	29 in.	$23\frac{1}{4}$	1,810
Canadian Thorpe	"	1x8	" 9	" 9	" 22	28 in.	15	1,980
Manscheuri 6-Rowed	"	1x8	" 9	" 5	" 13	31 in.	$27\frac{1}{4}$	2,100
Bonanza	"	1x8	" 15	" 6	" 14	44 in.	35	2,960
Hammond's Colossal	Hulless	1x8	" 15	" 5	" 19	33 in.	$11\frac{3}{4}$	3,820
White Hulless	"	1x8	" 15	" 4	" 19	29 in.	$14\frac{3}{4}$	4,240
Silver King	Bearded	1x8	" 16	" 5	" 15	43 in.	$34\frac{7}{12}$	4,360
Beardless	Beardless	1x8	" 16	" 4	" 19	42 in.	$30\frac{5}{6}$	2,900

Spring Rye.—One plot, 1x8 rods was planted May 15. The plot was damaged by aphis nearly as much as the wheat plot, though the grain making a more rapid growth was better able to withstand the ravages of the pest. It headed out June 26 and was cut August 21, the straw being 55 inches long. The plot yielded 84 lbs. of grain and 305 lbs. of straw, being equal to 35 bushels of grain and 6,100 lbs. of straw per acre.

Buckwheat.—A small plot, $\frac{1}{2}$x6 rods, was planted June 4, with the Japanese variety. The plants were up with the true leaves just appearing when struck by the frost June 12. Though some of the leaves were browned, none of the plants appeared to suffer from the damage and an even stand was secured, reaching a height of 42 inches when beginning to blossom July 10, and an average height of 50 inches when cut September 10. While the day temperature in August was high, the nights were cold, and this together with the excessive rains of both July and August, caused the grain to ripen very unevenly, much of the seed was lost thereby, and still more shelled out by repeated handling before threshing, while a good share of the balance was harvested by blackbirds while on their way going south.

Field Peas.—All the varieties remained free from aphis and other insects. As during former seasons, the plants made a very rank growth of vines and pods, and together with the wet weather, the heavy masses of vines made the ripening of the peas anything but successful. A new variety the Golden Vine, was tested, it being claimed for it that the vines grow to an average length of $3\frac{1}{2}$ feet. All the vines from the other varieties grew to the former length of 9 to 11 feet. The Golden Vine, which appears to be a late variety, reached an average length of $9\frac{1}{2}$ feet. The peas are small, perfectly round, dark straw color and of good quality,

resembling the Egyptian Mummy, but slightly darker colored. Cut September 8 and 9, except Golden Vine, which was cut September 30, it was after the middle of October before any of the peas could be hauled to the barn, and by that time most of the ripest peas were shelled out. As a crop for plowing under, all varieties were a success, the well cured vines giving a yield per acre as follows, the vines of the Golden Vine variety not being as well cured as the others however, being harvested three weeks later and all being weighed at the same time when hauled under cover.

Canada Beauty	3,080 lbs.
Scotch	4,840 lbs.
Blackeyed Marrowfat	4,420 lbs.
Prussian Blue	3,460 lbs.
Egyptian Mummy	3,740 lbs.
Golden Vine	5,060 lbs.

Flax.—A small plot, ½x6 rods, was planted May 15, and an even stand secured, the plants beginning to blossom July 9 and averaging 37 inches in height. The seed was ripe September 10, and though much of it was lost by shelling and imperfect threshing, there remained 16½ lbs. of good, bright seed, or at the rate of nearly 16 bushels per acre.

Corn.—The testing of early varieties was continued, not with any hope of obtaining results strikingly better than before, even had the weather been as favorable as during 1902. As stated in our last report, this hope is not expected to be realized as long as dozens of miles of the surrounding territory remain an unbroken forest. In the absence of any accurate statistics to support this contention, the following from a recent bulletin of the Florida Experiment Station may be of interest: "It has been found that a system of clearing so as to facilitate a free circulation of the air has greatly lessened the liability of frost in sections on the east coast. Many localities in that region which at one time were decidely frosty, are rarely injured now by cold, and this is attributed to the large amount of clearing that has been done in the neighborhood." (Bulletin No. 68, page 696, Florida Experiment Station, June 1903, H. K. Miller and H. Harold Hume.) It cannot well be claimed that what applies to Florida will not apply to Michigan as well.

While the weather conditions for corn were much more unfavorable during 1903 than during any previous season, several varieties, especially the Dakota Yellow Dent, would have ripened, had it not been for the unusually cold nights during August. Scarcely any variety showed damage from the frost of September 6, and the more advanced varieties were not seriously hurt by the second September frost on the 29th.

The tests of the present season show that the question of variety is of first importance. The results do not seem to bear out the general contention that the flint varieties are earlier maturing and hardier than the dent varieties, for both the Dakota and the Northwestern Dent were farther advanced than any of the flint varieties when final observations were taken at the end of September. Nor are all the flints hardy or early maturing, since Golden Superb was last to tassel among all varieties, and the plants were not fully grown at the end of the season though the plot had the best exposure, while several of the other plots were partially deprived from sunshine by the nearby standing timber on the west side. The following table shows the varieties tested and their condition at the end of September:

Varieties.	Style.	Planted.	Tasseled.	Height in feet.	Condition at close of season.
Dakota	Yellow Dent	June 1	Aug. 9	8	Glazed. Many ears well dented.
Race Horse	"	" 4		7	Not full grown. No tassels.
Northwestern	"	" 2	" 10	7½	A few ears well glazed.
American Pride	"	" 3	" 23	7½	Very few in silks Not full grown
Rustler	White Dent	" 2	" 21	7	A few silked out. Not full grown.
Thoroughbred	"	" 5	" 22	9	A few in silk. Not full grown.
Giant	"	May 30	" 25	8½	A few beginning to silk. Not ful grown
Longfellow	Yellow Flint	" 30	" 10	7	A few ears beginning to glaze.
Golden Superb	"	June 4	" 28	6	A few silked out. Not full grown.
Sixty Day	"	" 2	" 11	6½	A few ears beginning to glaze.
Triumph	"	" 2	" 10	7	All silked out. None started to glaze.
Tom Thumb	Pop corn	" 6	" 26	5½	A few silked out.
Tatooed Yankee	"	" 5	" 7	6	All silked out and a few ears well glazed.
Yard Long	Yellow Dent	" 5	" 26	7	None silked out. Not full grown.

FORAGE CROPS.

Though outdoor curing was at times a difficult task, the cool and wet weather was highly beneficial to the rapid growth of all forage crops. Several of the grasses planted in 1902 gave two crops as did the clovers, while alfalfa gave its usual three crops. Several small plots of pasture grasses were planted during May of the present season, and even two of these yielded two crops as shown in the following table. Owing to the stony and poor condition of the brome grass plot, only one crop was removed, the second crop which averaged 15 inches high by the middle of September, being left as a mulch. The plot marked Sand Lucerne in the table, and planted in May, turned out to be a plot of alfalfa. Evidently the seed is scarcer or higher priced than the ordinary alfalfa seed. Between Giant Incarnate and the ordinary crimson clover no difference could be observed except in the higher price of the seed for the Incarnate variety. One plot of Berseem or Egyptian clover was planted in May and what there was of it was cut July 21 when begining to blossom. Less than one-fifth, however, was clover, over one-half being the branching wild mustard and one-third being a collection of other noxious weeds. As a digression, if it may be considered such, it may be stated that the station is not alone in being imposed upon with spurious seeds, chess (Bromus secalinus) and other weeds having been sent to the station for identification during the season, the farmers stating them to have been introduced with the high priced seeds. To sell common seeds under high sounding names and at fancy prices, or to sell weed seeds should be considered at least as illegitimate as selling oleo for butter or sawdust for bran. Until proper legislation is enacted it will seem incongruous to punish the farmer for not exterminating weeds, the seeds of which he may have innocently purchased at fancy prices. This is particularly felt in a new region like this, where most of the common weeds are as yet scarce and can be made to remain so without imposing any hardship upon anybody.

Varieties.	Time of planting.	Size of plots, in rods.	Time of cutting.	Yield per cutting, in lbs.	Total yield of plot, in lbs.	Yield per acre, in lbs.
Turkestan alfalfa	May, 1901..	1x6	July 6....	90		
"	" 1901..	1x6	Aug. 25....	68		
"	" 1901..	1x6	Sept. 17....	40	198	5,280
French alfalfa	" 1901..	1x6	July 6....	106		
"	" 1901..	1x6	Aug. 25....	71		
"	" 1901..	1x6	Sept. 17....	48	225	6,000
German alfalfa	" 1901..	1x6	July 6....	154		
"	" 1901..	1x6	Aug. 25....	87		
"	" 1901..	1x6	Sept. 17....	53	294	7,840
American alfalfa	" 1901..	1x6	July 6....	116		
"	" 1901..	1x6	Aug 25....	74		
"	" 1901..	1x6	Sept. 17....	47	237	6,320
Sanform or Esparcette	" 1902..	1x6	July 6....	....	69	1,840
June clover	" 1902..	1x6	July 7....	148		
"	" 1902..	1x6	Aug. 17....	98	246	6,560
Alsike clover	" 1902..	1x6	July 7....	198		
"	" 1902..	1x6	Sept. 9....	114	312	8,320
Silesian clover	" 1902..	1x6	July 7....	164		
"	" 1902..	1x6	Aug. 17....	106	270	7,200
Sand lucerne (?)	" 11,1903	1x6	Aug. 14....	69	69	1,840
Giant Incarnate clover	" 15,1903	1x6	Aug. 13....	165	165	4,400
Timothy	" 1902..	1x6	July 15....	160		
"	" 1902..	1x6	Sept. 18....	32	192	5,120
Orchard grass	" 1902..	1x6	July 6....	92		
"	" 1902..	1x6	Sept. 18....	25	117	3,120
Red top	" 1902..	1x6	July 15....	121		
"	" 1902..	1x6	Sept. 18....	29	150	4,000
Tall Meadow Oat Grass	" 15,1903	1x6	Aug. 25....	68		
"	" 15,1903	1x6	Sept. 18....	25	93	2,480
Slender Wheat grass	" 15,1903	1x6	Aug. 31....	111		
"	" 15,1903	1x6	Sept. 18....	33	144	3,840
Hungarian millet	Jun.4, 1903	½x6	Sept. 3....	....	165	8,800
Bromus Inermis	May. 1901..	4989 sq ft	July 15....	....	472½	4,125½

One plot was planted with the common Sand Vetch in August, 1902, with the expectation of ripening the seed. A good stand was secured and the plants covered the ground at the beginning of winter. At the beginning of spring the plants on the west half of the plot started a new growth as soon as the snow had left the plot, soon covering the ground and blossoming June 12, neither blossoms nor vines showing any signs of damage from previous frosts. The highway on the east side of the station grounds used to run across the other half of the plot and here the ground was soon covered with quack grass and Shepherd's Purse. Before the end of June there were few weeds to be seen, however, and the entire plot was soon a mass of purple Vetch blossoms. With the wet weather which followed, the vetches made a riotous growth, and of a

number of vines pulled up at random late in August, none measured less than 10 feet, while most exceeded 11 feet without being unduly stretched. Considering the weather and the mass of vines, the ripening of seed became a hopeless task. As soon as the vines were removed and the weeds came up, the ground was plowed and fitted for winter wheat. Before winter set in, a careful but unsuccessful search was made for quack grass and it is doubtful if the vetches have left any to reappear in the wheat next season. It should be stated that in the southern part of the State, vetch has sometimes degenerated into a bad weed, very hard to eradicate.

One plot which had grown Giant Spurry during the preceding season, was planted with Mammoth clover. The seed was evidently poor, as only a few scattering plants came up. The vacancies became soon filled with spurry and before the plants started to blossom the ground was plowed and harrowed a week after. A second crop of spurry was soon in evidence and was disposed of with the cutaway harrow, the ground being afterwards fitted for winter wheat. No spurry plants could be found at the beginning of winter.

Three small plots were planted with Japanese, Siberian and Broom Corn or Hog Millet with the expectation of ripening the seed. Owing to the cold weather in August the seed was slow in ripening and remained rather light after the plants were damaged by the September frosts. Another variety, Pearl or Cat tail Millet, failed to head out.

The following varieties were planted May 15, and made a satisfactory growth but not sufficient to warrant cutting during the same season: White Clover, Meadow Fox Tail, Kentucky Bluegrass, Bromus Erectus and Meadow Fescue. A small plot was planted with Yellow Lupine and a poor stand secured. The plants which came up made a very good growth, blossoming August 21 and setting numerous pods. No seed ripened though the plants showed no damage from frosts until after October 24.

Millo Maize, Japanese Broom Corn and Early Minnesota sorghum failed to head out.

Of three varieties of cow peas, the Early Black Eye and Hammond's Extra Early made a growth of 5 and 3 inches respectively, while Evans' New Era reached a height of 16 inches before killed by the September frosts.

Seven varieties of Soy Beans were tested. Ito San, Medium Early Black and the Ogemaw made the best showing, blossoming August 22, 20 and 17, respectively, and the pods being mostly well filled out, though none ripened sufficiently for seed. The first two made a very dense growth, the stalks averaging 36 inches high, while the Ogemaw remained somewhat more slender and reached a height of 30 inches. Extra Early Black (seed from Michigan Experiment Station) made a better growth than Ogemaw, but fewer pods filled up, blossoming August 22. Evans' Early Black Soy and Hammond's Extra Early Black blossomed August 31 and none of the pods filled up, while the Medium Early Green soy had the finest stalks and most leafage but set no pods.

One plot of Dwarf Essex Rape and one of Thousand Headed Kale were planted May 27, in drills 18 inches apart and the plants thinned out to 10 inches in the row. Three cultivations were given before the plants shaded the ground, and the plants in both plots reached a height of 36 inches, being left for ripening seed next season. No appreciable difference could be observed between the plants of the two varieties, the Kale being slightly more branching and the color of the leaves having a bluish cast.

In 1902, a small plot, 4 rods square, upon which the rape seed had been broadcasted was left for seed, after one-half of the plot was cut for feed by mowing off the plants 5 inches above ground. The plants started a new growth before the snow disappeared in the spring of 1903 and started to blossom June 2, the lower branches ripening seed late in July. Stimulated by wet weather and by myriads of cabbage aphis, the plants continued to blossom and ripen seed until the end of the season, the aphis being kept in check by spraying with soap and tobacco water Individual plants reached a height of 74 inches and by the latter part of August the ground was covered with a thick mat of new rape plants from the shelled out seed. Though a very large per cent of the seed was subsequently lost in handling the crop, 19 lbs. of prime seed were collected from he plot, or at the rate of 760 lbs. per acre. Considering the favorable winter conditions and the extreme hariness of the plants, the crop appears to be admirably well adapted for this region and would seem to be profitable at least as long as most of the seed is imported from Europe. Whenever it seems wise to provide

this station with stock, the very important and economical fact can be determined whether this crop can be pastured with sheep or other stock and still produce a profitable crop of seed. The observations made during the season would seem to indicate that success in this direction is at least probable, the only difference which could be noticed between the plants which had been cut for feed and those which were left untouched, was that the former, being not as heavily branched, were able to ripen the seed earlier and more evenly. Very small plots of abouts one-half rod square were planted with the following vetches and forage plants.

Vicia Sativa Typica.—Planted June 5. Blossomed August 9. Resembles the common spring vetch, the leaves being larger and the vines being coarser and longer, averaging 7½ feet in length at the close of the season. Pods exceeding 3 inches in length formed, but no seed ripened.

Vicia Biennis.—Planted June 5. Blossomed July 23. In appearance like the common Sand or Winter Vetch. The blossoms are smaller and of a more reddish purple. The leaves are smaller and the vines more slender, averaging 8½ feet in length. Like its relative the Sand Vetch, it made a rank growth and formed a compact mat of vines which will no doubt prove more valuable for feed or fertilizer than for seed. No pods could be found.

Vicia Peregrina.—Planted June 1. Blossomed August 16. Vines more slender and leaves smaller than Sativa typica. Both of these would have probably ripened seed if planted earlier. Bumble bees and similar beneficial insects appreciate the handsome pink and white blossoms of these spring vetchs and these plants in orchards or near small fruit plantations should be of the greatest value even outside of the high fertilizing value which they yield as legumes. None of these two nor Vicia biennis were affected by September or early October frosts, and merely the tips of the vines wilted after the killing frost of October 24.

Lathyrus Ochrus or *Ochrus Pea.*—Planted June 1. Blossomed July 22, the blossoms being pure white and resembling those of field peas. This variety grows more upright, the vines seldom exceeding 4 feet in length. The peas ripened late in August and in size are somewhat smaller than Egyptian Mummy. Thoroughly ripening in a season as wet and cold as the past, this variety ought to be considered a very valuable acquisition as a legume.

POTATOES AND ROOT CROPS.

As during previous seasons, the potatoes were planted 18 inches apart in rows 4 feet apart and level cultivation was given throughout the season. Potato bugs and both early and late blights were more damaging than during any other season. The total yield of the crop was not materially affected thereby, but the development of the tubers being checked, the yield of large and small potatoes was out of the ordinary proportion. Potato rot began to develop towards the end of August, but harvesting the crop late and storing the potatoes in crates restricted the loss to less than five per cent. To keep the vines immune by sufficient sprayings during a season of almost continuous rains would have been impracticable.

With each harvest, it becomes more evident that early varieties cannot be recommended for this region. The reasons which lead to this conclusion are, first, the yield is small; second, the size of the tubers is seldom large enough except for home consumption; third, the period which elapses between the ripening of the early and that of the late varieties is insignificant in this latitude.

Varieties tested for the first time are,

Million Dollar.—A late white potato of the Carman type, oblong to round, flattened and usually thickest at seed end. Finely netted with eyes, mostly shallow and open. Flesh dry and of good quality.

Up-to-Date.—A late white variety, oblong to round and sometimes flattened. Eyes broad, open, shallow. Skin slightly netted; quality good.

Wonderful.—A medium early variety. Color light brown, eyes white, broad, very shallow and often bulging. Roundish oblong, skin prominently russeted; flesh dry and of good quality.

Admiral Dewey.—As tested here it is impossible to describe the variety or state whether the otherwise satisfactory yield is due to one rather than the other of

the several shapes or colors, the whole being a medley collection of all shapes ranging from round to oblong and of all colors shading from pure white to dark red. It is evident that varieties advertised under such "catchy" names are apt to produce not only "admirals" but almost anything usually found upon a flagship.

The following table shows that Sir Walter Raleigh is still the leading variety, with Million Dollar as a promising sort.

Varieties.	Size of plots, in rods.	Time of planting.	Time of blossoming.	Yield of plot, in bu.		
				Large.	Small.	Total.
Northlight	1x4	June 2	July 29	2¾	1¾	4½
Northern Beauty	1x4	" 2	" 12	3¼	1¾	5
Pride of Michigan	1x4	" 2	" 14	3¾	1¾	5½
Wonderful	1x2	May 30	" 18	1¼	¾	2
Admiral Dewey	1x2	" 30	" 12	2½	½	3
Million Dollar	1x2	" 30	" 23	3¼	½	3¾
Up to Date	1x2	" 30	" 13	2	¾	2¾
Rose of Erin	3x3½	June 2	" 12	12	1½	13½
Rosy Morn	2x4	May 30	" 10	5½	2	7½
Pinkeye	1x5	June 4	" 19	3½	1¾	5¼
Irish Cobbler	1x2	" 5	" 12	¾	½	1¼
Pingree	1x4	May 30	" 12	2	1	3
Honeoye	1x4	June 1	" 14	1¾	½	2¼
Dew Drop	1x4	" 2	" 15	3	1	4
Hurst	1x4	" 2	" 11	3	1	4
Delaware	1x4	" 2	" 14	5	1	6
Harrington Peer	1x4	" 1	" 13	4½	1¼	5¾
Sir Walter Raleigh	2x4	" 1	" 20	14	½	14½
Carman No. 3	2x4	" 2	" 14	10	1¾	11¾
Six Weeks	1x4	" 3	" 16	3	1	4

CONTINUATION OF POTATO EXPERIMENTS.

The potato experiments were continued on the same ground upon which the experiments were carried on in 1901-1902, the ground being simply harrowed after the potatoes had been harvested in 1902. As during the previous season, the object of the experiments consisted in testing the value of fall planting as compared with spring planting, level cultivation and spraying against blight as compared with hill culture and spraying for potato bugs only. The fall planting was done November 1, whole potatoes being used and planted about four inches deep and 18 inches apart, the rows being 4 rods long and 4 feet apart. Four additional rows were planted with the Sir Walter Raleigh variety, the potatoes being cut in halves and rolled in air slaked lime. Two rows of these were planted 5 inches deep and the other two rows 2 inches deep. The cut potatoes were a failure, the few hills which came up in spring producing only a few small potatoes. No appreciable difference could be observed between the deep and the shallow planted rows. In both the cut seed was found mostly dried up, most of the buds being still fresh but small and weak. Notwithstanding the fact that the ground was frozen 5 inches deep when permanent snow fell on December 3, all of the whole potatoes came up, and neither the appearance of the vines nor the subsequent yield indicated that the seed had been damaged. In fact, many potatoes missed when harvesting other plots and plowed up during spring, showed no sign of damage from frost, and being cooked, were found as good if not better than fall dug potatoes. It would seem evident therefore that neither the quality nor the vitality of potatoes is affected by moderate frosts as long as the potatoes remain undug and undisturbed until after the ground is thawed out, though it is more than likely that the potatoes would be damaged should alternate freezing and thawing of the ground take place.

In order to make more accurate comparisons between fall and spring planting, whole potatoes were used for spring planting. The cellar in which the seed potatoes are kept over is much poorer than the average, and at planting time more than ordinary care was taken to save the sprouts which had developed. While,

as shown in the table below, the slight increased yield of the spring planted potatoes may be due to the weakening of the fall planted seed, this is rather likely to be due to the extra care which in ordinary field practice could not be given to spring planted seed, and for that matter would be practically impossible whenever the seed potatoes are cut.

While the total yield of the unsprayed potatoes is slightly greater than that of the potatoes which were sprayed against blight, it would be neither safe nor fair to conclude that during wet seasons such spraying is a damage to the crop. It is true that Bordeaux mixture is apt to damage the foliage during wet and cold weather, but it is equally true that the damage at such times can be averted by adding a little more lime to the mixture. This extra precaution was taken, and though the results were negative or apparently so in the case of potatoes, it proved highly beneficial in the case of plum and cherry trees. While during a season as wet as the past, the persistent spraying of potatoes might prove efficient, it is doubtful whether it would prove to be profitable. The advantage of level over hill culture is best illustrated in the present results. Hill culture during wet seasons would likely give best results on soil insufficiently drained, hence poorly adapted for potatoes. On natural potato ground there should be no question about the superiority of level culture whether the season is wet or dry. As above stated, one-half of the plots was planted November 1, 1902. The other half was planted May 29, 1903. The varieties used were Norther and Pingree, two early varieties, Rose of Erin and Wonder of the World, two medium late, and Carman No. 3 and Sir Walter Raleigh, two late varieties. The vines of the early varieties were dead August 17 and the potatoes were then fit for digging. The vines of the medium late varieties were dead August 28 and those of the late varieties September 30. In all varieties, blight materially hastened the dying of the vines. Of potatoes dug August 28 and 29, quite a percentage rotted subsequently, but practically no further loss was sustained with the balance by harvesting the potatoes between October 14 and 20. The following table gives the date of sprouting and blossoming, the date of sprouting being the time when the rows could be distinguished.

Fall Planted.		Varieties.	Spring Planted.	
Time of sprouting.	Time of blossoming.		Time of sprouting.	Time of blossoming.
June 4	July 4	Pingree	June 12	July 9
" 3	" 5	Norther	" 14	" 9
" 7	" 6	Rose of Erin	" 15	" 9
" 1	" 7	Wonder of the World	" 14	" 10
" 5	" 9	Carman No. 3	" 14	" 13
" 9	" 12	Sir Walter Raleigh	" 16	" 20

The frost of June 12 killed back the tops of all fall planted varieties and those of the spring planted Pingree variety. While the fall planted rows were all green again June 14, the rows of the spring planted Pingree variety had only partially recovered June 17.

All varieties were sprayed June 27 and 29, July 7, 9 and 14.

TABLE OF FALL PLANTED POTATOES IN ROWS FOUR RODS LONG.

Sprayed or unsprayed.	Varieties.	Number of rows.	Hilled up. Large.	Hilled up. Small.	Hilled up. Yield of plot in lbs.	Hilled up. Yield per acre, in bu.	Cultivated level. Large.	Cultivated level. Small.	Cultivated level. Yield of plot in lbs.	Cultivated level. Yield per acre, in bu.
....	*Sir Walter Raleigh	4	......	......	......	......	......	......	......	......
Sprayed.................	"	3	137	15	152	278⅔	134	19	153	280½
Not sprayed............	"	3	138	12	150	275	141	11	152	278⅔
Sprayed.................	Carman No. 3	3	84	12	96	176	88	13	101	185⅙
Not sprayed............	"	3	80	11	91	166⅚	89	7	96	176
Sprayed.................	Rose of Erin...............	3	79	11	90	165	82	14	96	176
Not sprayed............	"	3	78	10	88	161⅓	79	12	91	166⅚
Sprayed.................	Wonder of the World	3	51	19	70	128⅓	52	26	78	143
Not sprayed............	"	3	48	17	65	119⅙	52	17	69	126½
Sprayed.................	Pingree....................	3	40	18	58	106⅓	51	11	62	113⅔
Not sprayed............	"	3	51	12	63	115½	48	12	60	110
Sprayed.................	Norther	1	13	3	16	88	9	6	15	82½
Not sprayed............	"	1	18	4	22	121	13	7	20	110
	Total....................		817	144	961	......	838	155	993	......

*Failed to sprout.

TABLE OF SPRING PLANTED POTATOES, IN ROWS FOUR RODS LONG.

Sprayed or unsprayed.	Varieties	Number of rows.	Hilled up. Large.	Hilled up. Small.	Hilled up. Yield of plot, in lbs.	Hilled up. Yield per acre, in bu.	Cultivated level. Large.	Cultivated level. Small.	Cultivated level. Yield of plot, in lbs.	Cultivated level. Yield per acre, in bu.
Sprayed.................	Sir Walter Raleigh ½'s.......	4	129	29	158	217¼	151	14	165	226⅞
Not sprayed............	" ½'s.......	4	136	19	155	212⅛	142	20	162	222¾
Sprayed.................	Sir Walter Raleigh, whole.....	3	119	23	142	260⅓	127	14	141	258½
Not sprayed............	"	3	120	20	140	256⅔	130	16	146	267⅔
Sprayed.................	Carman No. 3	3	69	23	92	168⅔	99	9	108	198
Not sprayed............	"	3	78	18	96	176	90	17	107	196⅙
Sprayed.................	Rose of Erin	3	81	15	96	176	86	10	96	176
Not sprayed............	"	3	101	18	119	218⅙	108	19	127	232⅚
Sprayed.................	Wonder of the World	3	44	18	62	113⅔	54	20	74	135⅔
Not sprayed............	"	3	52	16	68	124⅔	55	18	73	133⅚
Sprayed.................	Pingree....................	3	34	7	41	75⅙	46	10	56	102⅔
Not sprayed............	"	3	40	12	52	95⅓	67	15	82	150⅓
Sprayed.................	Norther	1	8	3	11	60½	12	6	18	99
Not sprayed............	"	1	9	3	12	66	13	4	17	93½
	Total....................	....	1,020	224	1,244	......	1,180	192	1,372	......

The fall planted varieties were cultivated June 10, 18 and 24, and July 6 and 15, while the spring planted rows were cultivated June 18 and 24 and July 6 and 15. Hilling up was partially done July 6 and finished July 8. Observations of the late varieties were taken three times, viz.: September 5, when the fall planted were nearly full grown, while the spring planted were barely two-thirds grown. September 18 the spring planted were nearly full grown, while the fall planted were sufficiently ripe, the skin being firm. September 30, when the tops were nearly killed by the frost of the preceding day, the spring planted were nearly, though not sufficiently ripe. As shown in the tables below, the percentage of small potatoes was greatest in the spring planted rows and while the total yield of spring planted is greater than that of the fall planted, the figures are nearly reversed if the merchantable potatoes only are taken into account.

Adding up the total yields of all plots and leaving out the four rows of cut seed of the Sir Walter Raleigh variety, the results are as follows:

Spring planted	1,976 lbs.
Fall planted	1,954 lbs.
In favor of spring planted	22 lbs.
Not sprayed	2,006 lbs.
Sprayed	1,924 lbs.
In favor of not sprayed	82 lbs.
Level cultivation	2,038 lbs.
Hilled up	1,892 lbs.
In favor of level culture	146 lbs.

SUGAR BEETS.

The tests with sugar beets were continued with the intention of studying the relating facts as influenced by the peculiar climatic conditions of this region. The co-operative experiments made in 1902 and related in Bulletin No. 207 and Special Bulletin No. 18, brought out the now undisputable fact that beets richest in sugar content grow at the northern limit of possible production. This in no small measure stimulated the erection in 1903 of the largest beet sugar factory in the State, and the vastness of this yet undeveloped region lends added interest to the study of all the phases of the sugar beet problem, since one may expect that these northern regions may eventually become the center of greatest activity in the production of sugar beets. The two problems of special importance are: first, the production of sugar beet seed; second, the effect upon the sugar content of the beet and upon the beet itself by being left unharvested until spring. Should all other conditions prove favorable, there is good reason to expect that the production of high grade seed will be more rapidly accomplished in northern regions, since the tendency of the beet in accumulating an extra percentage of sugar with nature's gratuitous aid, might reasonably be expected to be transmitted to the seed.

A portion of the sugar beet plots was left unharvested in order to determine during spring of 1904 the value of storing beets by this unique method. Should ultimate tests prove that the beets undergo no change, perhaps even gain by this process, there will have been pointed out an added incentive for sugar beet production, and its importance can hardly be overestimated whenever ample acreage can be secured.

On page 3 of Special Bulletin No. 18, mention is made of the laboratory test for ascertaining the shrinkage of samples of beets during transportation. In order to ascertain such shrinkages as it occurs in actual practice, sample beets were pulled and shipped the same day both to the Menominee River Sugar Co., at Menominee, Mich., and to the Agricultural College, a tag being fastened to each beet giving the weight at the time of shipping. The results are shown in the following table, giving also the sugar content and purity as analyzed. The average test of all beets gives a sugar percentage of 16.4 and 86.4 purity at the Menominee sugar factory.

BEETS SHIPPED TO MENOMINEE.

Number	Variety.	Weight when shipped, in ounces.	Weight when delivered, in ounces.	Shrinkage, in ounces	Percentage of loss.	Sugar content.	Purity.
1	Jaensch's Victrix	21½	21	½	2.32	16.5	86.6
2	"	24	24	0	0	16	84.3
3	Fredeickswerther Elite	16½	16	½	3.03	16.7	88.3
4	"	32	31	1	3.12	16.4	84.5

The two varieties were planted May 20, in rows 18 inches apart, each plot being 1x6 rods. Though a portion of the plots were several times under water after heavy rains, the beets suffered no appreciable damage. One-half rod of each plot was left unharvested, the balance of the plots giving the following yield of trimmed and topped beets:

Jaensch's Victrix, 950 lbs., or 27,636.36 lbs. per acre.

Frederickwerther Elite, 900 lbs., or 26,181.81 lbs. per acre.

Returns from beets shipped to the Agricultural College were as follows:

AVERAGE TEST, SUGAR AND PURITY.

Variety.	Weight when shipped in ounces.	Weight when delivered, in ounces.	Shrinkage, in ounces.	Per cent sugar found.	Actual sugar content
Jaensch Victrix	16	12½	3½	20.6	16.1
"	15	12½	2½	20.2	16.8
"	19	16	3	19.6	16.5
Fredereickswerther Elite	24½	20	4½	17.8	14.5
"	28	23	5	18.6	15.4
"	27½	22	5½	18.4	14.6

TURNIPS, BEETS, CARROTS, ETC.

Though all varieties made a good showing, the yield was probably much less than it would have been if the plots could have been cultivated more frequently and the weeds properly subdued. Among the varieties not heretofore tested, the following are worthy of note:

CARROTS.

Selected Danvers.—A table carrot of medium size and good quality. Color, light orange with light colored center, long tapering tap root. Flesh crisp and sweet.

Long Lemon Stump-Rooted.—Long tapering root, averaging 7 inches and holding its size fairly well. Yellow fleshed and sweet, but somewhat coarse. Quality fair.

Earliest Short Horn.—The earliest maturing variety. Roots short, heart-shaped and hollow crowned, with orange colored flesh. Crisp and sweet. Quality good. For general culture, *Chantenay* is probably the best table carrot.

Mastodon of the stock carrots resembles and is probably identical with *White Vosges* heretofore tested.

RUTABAGAS.

White Swede.—Of good size, somewhat globe-shaped, abruptly terminating with a small tap root. Color white on top, with purple and green shadings below. Flesh tender, light colored and of good cooking quality.

Improved Yellow Mammoth.—Of large size when full grown. Long tapering tap root. Yellow colored with dark purple top. Flesh dark yellow, firm, sweet and of good quality.

Carter's Elephant.—Medium to large. Of good shape, with single small tapering tap root. Color light orange with purple top. Flesh crisp, tender and sweet. Of very good quality.

TURNIPS.

Early Bay City.—Resembles and probably is the common purple top, strap leaved flat turnip, which in the table below is given with an indicated yield of 853 bushels per acre. This variety was fit for table use July 21, being next to *White Flat Strap Leaf*, a few of which were harvested July 16. The greater yield of the two last named and of *Milk Globe*, is due to the fact that they were harvested at the end of the season, hence full grown and fit only for stock food.

Orange Jelly.—Nearly globe-shaped and light orange colored. Of very good quality when used before full grown and will keep much longer than the white or common purple top varieties.

New Japanese Tennoji.—A white variety of poor shape and worse quality. Perhaps the seed was poor, as all ran to seed before being more than half full grown.

Scarlet Kashmyr.—The bright scarlet and white coloring makes this an attractive looking variety. The white flesh is very firm and crisp, but neither juicy nor very sweet.

Cow Horn.—Grows to large size and cow horn fashion, single specimens sometimes exceeding two feet in length and three to six inches in diameter. Is used for stock and frequently as an orchard cover. Including tops, the yield would probably exceed 40 tons of vegetable matter per acre, though 90 per cent of this would of course be water.

Purple Top Yellow Aberdeen.—Round, globe-shaped and slightly flattened with small tap root. Skin yellow, shaded with crimson and dark purple on top. Flesh light yellow, juicy and fairly sweet. Fit for table use until late fall and will grow to large size.

PARSNIPS.

Long White Dutch or Sugar.—Long tapering root, holding its size fairly well. Slightly hollow crowned. Flesh sweet and of good quality.

Improved Guernsey.—Medium long and rather abruptly tapering root. Somewhat smaller than the last but of equally good quality.

The yields of all varieties tested are shown in the following table:

Varieties.	Size of plot, in rods.	Time of planting.	Yield of plot, in bushels.	Yield per acre, in bushels.
Turnip—Early Bay City	⅝ x 6	May 25	11¼	480
" Milk Globe	½ x 6	" 26	12	640
" New Japanese Tennoji	¼ x 6	" 26	3	320
" Scarlet Kashmyr	½ x 6	" 27	5	266⅔
" Orange Jelly	⅝ x 6	" 27	12¼	522⅔
" Purple Top Yellow Aberdeen	¾ x 6	" 22	14½	515 5/9
" Cow Horn	⅛ x 6	" 27	6¼	1,333⅓
" White Flat Strap Leaf	⅛ x 6	" 27	3	640
" Purple Top Strap Leaf	⅛ x 6	" 27	4	853⅓
Rutabaga—Monarch or Tankard	¾ x 6	" 22	14	497 7/9
" Shephard's Golden Globe	⅝ x 6	" 25	9	384
" Improved Yellow Mammoth	⅜ x 6	" 26	8½	604 4/9
" White Swede or Sweet Russian Turnip	⅝ x 6	" 26	14½	618⅔
" Improved Purple Top	½ x 6	" 26	11	586⅔
" Carter's Elephant	½ x 6	" 26	11¾	626⅔
" Mammoth Russian	5.4 x 4	" 30	7½	480
Table Carrot—Long Lemon Stump-rooted	¼ x 6	" 23	3½	373⅓
" Selected Danvers	¼ x 6	" 23	3¼	346⅔
" Improved Long Orange	⅛ x 6	" 13	1¾	352
" Chantenay	⅛ x 6	" 13	1¾	352
" Earliest Short Horn	⅛ x 6	" 13	1½	320
Stock Carrot—Mastodon	⅛ x 6	" 13	3½	746⅔
" Large White Belgian	3.16 x 6	" 13	5	711⅑
Mangel—Improved Mammoth Long Red (D. M. Ferry)	¾ x 6	" 22	9½	337 7/9
" " (Northrop, King Co)	⅜ x 6	" 26	5	355 5/9
" Giant Holstein	½ x 6	" 26	6½	346⅔
Stock Beet—Giant Feeding Sugar Mangel	⅝ x 6	" 25	12	512
Parsnip—Improved Guernsey	¼ x 6	" 25	3½	373⅓
" Long White Dutch or Sugar	½ x 6	" 25	6¾	360
Table Beets—Chicago Market	⅞ x 6	" 23	7¼	221
" New Half Long Blood	½ x 6	" 26	8	426⅔
" Extra Early Egyptian Blood Turnip	½ x 6	" 26	7¾	413⅓
" Bastian's Early Turnip	1.12 x 6	" 26	1	320
" Crosbp's Egyptian	⅙ x 6	" 13	3	480
" Long Dark Blood	⅙ x 6	" 14	3½	560

TABLE BEETS.

Crosby's Egyptian.—An early variety, fit for table use by the middle of July. Round globular shape, with slightly tapering tap root. Dark red, with alternate layers of red and white flesh and dark green leaves.

Extra Early Egyptian Blood Turnip.—Flat turnip shaped. Skin dark blood colored and flesh with alternating layers of crimson and dark blood. Flesh somewhat coarse. Quality fair.

Long Dark Blood.—Skin and flesh very dark colored. Long tapering root of large size and inclined to grow cow horn fashion. A late variety of good quality.

Chicago Market.—Medium to large size, and round with small, abruptly tapering tap root. Skin dark blood colored. Flesh with dark red, crimson and white blending in alternate layers. Fine grained, of good quality and medium early, being ready for table use about the middle of August and probably earlier during a more favorable season. Both leaves and leaf stalks are very dark colored and strikingly handsome. Nearly one-half of these beets were harvested in August, hence before full grown, and this accounts somewhat for the lower yield shown in the table above.

GARDEN VARIETIES.

PEAS.

The trouble encountered with field peas is absent in the early varieties of the garden sorts and reduced to a minimum in the late maturing varieties, the vines making no such rank growth. There should be no trouble therefore, to ripen these varieties, even during wet seasons, should the attempt be made, though all varieties being very prolific, it would probably be advisable to "brush" late varieties, since the length of their vines still reaches or exceeds 6 feet, and since the numerous heavy pods would otherwise crush the vines down. Though all these varieties are intended to be harvested before reaching maturity, "brushing" is nevertheless recommended for the late sorts, as picking will be rendered much easier thereby. For quality, the late varieties take the lead, and among those tested, none surpasses *Teddy Roosevelt*, a relatively new variety resembling *Telephone*, with the vines somewhat shorter, and hence standing up better under the weight of the very large pods. The peas are very large, tender and sweet, with a spicy and most excellent flavor.

Melting Sugar.—An edible pod variety, with the longest vines, is the most prolific, as many as 50 pods being found on single vines. The pods are practically stringless and should be picked before the peas are more than half full grown, as they become "leathery" soon afterwards, but still remain edible if cooked from one-half to an hour longer.

The following table gives the names of the varieties tested and their description:

Varieties.	Time of planting.	Time of blossoming.	When edible.	Average length of vines, in inches.	Average length of pods, in inches.	Number of pods per vine.	Number of peas in pods.	Quality.
First and Best	May 23	June 30	July 18	24	3	6	7	Fair.
Nott's Excelsior	" 23	July 4	" 31	18	2¼	8	5	Good.
Melting Sugar, edible pod	" 23	" 11	Aug. 19	78	4	40	7	Very good.
Champion of England	" 23	" 12	" 12	54	3	14	7	Good.
McLean's Advancer	" 25	" 8	" 10	34	2¾	12	7	Good.
Teddy Roosevelt	" 26	" 14	" 5	48	4	10	7	Very good.
Monarch of All Peas	" 26	" 2	July 21	36	2¾	7	6	Fair.
Telephone	" 14	" 5	" 22	72	4½	14	7	Very good.
Gradus	" 14	June 20	" 15	48	3¼	9	6	Good.
Pride of the Market	" 14	July 9	Aug. 9	36	3½	11	6	Good.
American Wonder	" 14	June 25	July 14	22	3	6	6	Fair.

BEANS.

The six varieties of bush beans which were tested set a great abundance of pods and the wet and cool weather during the picking season was rather favorable for this crop. The varieties are described in the table below. Three varieties of pole beans were tested with the intention of ripening the seed. These

TABLE OF BUSH BEANS.

Variety.	Time of planting.	Time of blossoming.	When edible.	Height of bush in inches.	Length of pods in inches.	Notes.
Davis Wax	June 1	July 16	Aug. 6	16	5	Pods flat, narrow. straight stringless.
Detroit Wax	" 1	" 18	" 8	12	4½	Pods flat, broad, straight, nearly stringless.
Golden Wax	" 2	" 19	" 12	9	3¾	Pods flat, slightly curved almost stringless.
Early Fellow Six Weeks	" 2	" 22	" 16	10	3½	Pods flat, narrow, straight, nearly stringless.
New Early Brittle Wax	" 2	" 20	" 18	9	4½	Pods round, curved, stringless.
New Round Pod Kidney Wax	" 2	" 25	" 20	9	4	Pods round, curved, almost stringless

were Scarlet Runner, Willing's Pride and Yard Long. While not killed by the frost of September 6, their further growth was checked thereby and Scarlet Runner alone ripened a few pods. For picking green, Willing's Pride would have been a profitable variety, while Yard Long developed no pods. Two varieties of Bush Lima Beans were tested, viz.: New Wonder and Dwarf Bush Lima (Rice's) but no pods formed, the two blossoming August 10 and 12 respectively. Of seven varieties of field beans tested, six blossomed between July 20 and 30, though none ripened more than a few pods, except the Brown Swedish, of which approximately 50 per cent of the pods ripened. The other variety, although last to blossom on August 6, ripened nearly 20 per cent of the pods, the variety being Early Marrow Pea or White Navy. The failure in ripening the field and pole varieties was principally due to a severe attack of anthracnose, which owing to persistent wet weather could not be materially checked with Bordeaux mixture.

SWEET CORN.

Of the varieties tested, Adams, First in Market, Early Minnesota and Stowell's Evergreen in the order named, are the most promising. None of these were damaged by frost until after September 29, while about 25 per cent of First in Market and practically all of Adams ripened. This latter variety is especially worthy of further trials, for while only of medium quality as a table variety, it is superior to Cory, heretofore tested. The stalks also are higher, averaging 6 feet, and the foliage being abundant, this variety will furnish a large amount of fodder, while the grain being smooth, ought to be fully as good for stock feeding as the average field varieties. The ears average 8 inches long with 8 to 10 rows of large kernels.

For table use, First in Market, is somewhat sweeter and its earliness may show it to be a valuable sort for this latitude. The stalks are nearly 6 feet high with plenty of foliage and the ears average 9 inches with 12 rows of large kernels. Early Minnesota and Stowell's Evergreen are two well-known standard varieties of better quality than either of the two described above. Neither of the two ripened.

SQUASHES AND SUNDRY VINES.

All varieties were planted June 6, but the ground being cold and cut-worms being unusually abundant, the seed either failed to sprout or the young plants were destroyed as fast as they appeared above ground. All were replanted June 22 to 25. None of the muskmelons or watermelons set fruit, though the earliest variety of the former blossomed August 3 and the latest August 17. Among the cucumbers the earliest variety blossomed August 4 and the latest August 10. Some of these failed to bear and the others did not bear many specimens, these being Early Short Green, Earliest or Klondike, King of Picklers, Early Russian and Arlington White Spine, the first four being pickling and the last a slicing variety. The squashes and pumpkins proved more prolific and several varieties ripened thoroughly. As nearly all varieties tested gave promise of good results in normal seasons, the following notes are given:

PUMPKINS.

Sugar Pie.—A table variety of small to medium size and excellent flavor and quality, requiring less sugar than any other variety. Round and flattened at stem and blossom ends. Medium hard but thin shell; orange colored; flesh thick, fine grained and dark lemon colored. Will keep for two months in an ordinary cellar. Nearly every specimen ripened. Probably the best of all pumpkins, very prolific, and having been tested twice before, it can be safely recommended for general cultivation.

Mammoth Prize.—A large variety of very attractive appearance. In shape and color like the last, but more flattened. The shell is harder but very thin and perfectly smooth. Seed cavity much larger proportionately than the last. Specimens weigh 20 to 30 lbs., and several were nearly ripe.

Japanese Pie.—A late variety of small to medium size. In shape resembles a "Dipper" Gourd with the "neck" part or stem end 3 to 3½ inches and the blossom end 4 to 5 inches in diameter; 10 to 12 inches long; medium hard thin shell, smooth and dark green colored. Flesh thick and seed cavity small; quality fair. Kept in good condition for six weeks in ordinary cellar, though not quite ripe.

Hundred Weight.—Resembles Mammoth Tours, heretofore tested. Pear shaped and growing to very large size, the largest specimen weighing 56 lbs. Shell soft, smooth, with cream color mostly overlaid with light to dark green. Seed cavity very large. Flesh coarse and best fitted for stock food. Ripened thoroughly and kept in good condition for two months.

SQUASHES.

Mammoth Yellow Summer Crookneck.—The best known of the early or summer squashes and heretofore tested. Will usually ripen before the advent of any early frosts.

Hubbard, Mammoth Hubbard, and *Chicago Warted Hubbard*, each from a different seedsman, were practically the same thing. All ripened, but not to that degree which leaves the flesh dry and mealy.

Great Chile.—A variety of very large size and heretofore tested as Mammoth Chili. Did not grow as large as in 1902 nor ripen as well, the largest specimen weighing 41 lbs.

Hardshelled Marrow.—Resembles and probably is the same variety heretofore tested as Golden Hubbard. Did not ripen as well as the ordinary dark green Hubbard.

Fordhook.—Of small size, egg-shaped and prominently ribbed. Smooth, cream colored and thin but very hard shell. Seed cavity very small and flesh quite dry. Did not ripen sufficiently.

Italian Vegetable Marrow.—A medium early variety of large size and fair quality. Club shaped, 12 to 21 inches long and 4 to 6 inches in diameter at thickest or blossom end. Ribbed and soft shelled; flesh thick and soft. Color white, almost overlaid with light green and heavy stripings of dark green, the longitudinal ribs being greenish white with occasional minute splashings of dark green. Very prolific and growing in bush form. Quality fair. A few specimens were nearly ripe..

TOMATOES.

Seven varieties were tested. The plants were grown by the Negaunee Nursery and Greenhouse Co., who hardened them in cold frames, shipped them skillfully packed and thus furnished unusually strong and stocky plants which continued their growth unchecked when transplanted here June 20. The varieties, with dates of blossoming, were as follows:

Atlantic Prize, blossomed July 8.
Hammond's Earliest, blossomed July 8.
Nolte's Earliest, blossomed July 9.
Red Cherry, blossomed July 10.
Red Pear, blossomed July 22.
Tour Peach, blossomed July 23.
White Apple, blossomed July 25.

The effect of cold nights during August was best illustrated with the tomatoes. The vines were heavily loaded, and though the full grown fruit of the first four named varieties was at the turning point shortly after the middle of August, scarcely more than a half dozen specimens ripened out doors, though neither rot nor any other disease caused the loss of any. All were subsequently ripened in the house, the plants being unharmed by frost until after September 29. The earliest full grown fruit of Red Pear also ripened in the house, while that of the last two named varieties of above list developed to full size but was fitted only for green tomatoes.

RADISHES.

The small, early and usually turnip-shaped varieties can be rapidly grown in hot beds early in season, or outdoors as soon as the ground is warm enough. Grown outdoors, it means wormy radishes, should planting time be succeeded by a protracted spell of cold, raw weather. This can largely be averted however by mixing a liberal supply of tobacco dust with the soil in the rows when ready to sow the seed. Of these early varieties, the following were tested: *Early Deep Scarlet, Olive Short Leaf, Non Plus Ultra or Scarlet Turnip Forcing, Scarlet Turnip White Tipped, Crimson Giant Forcing* and *Triumph.* Planted May 13, they were of edible size June 14 to 17, while replanted June 12 they were edible July 6. All these varieties are of excellent quality, Non Plus Ultra being the smallest and earliest maturing and Crimson Giant Forcing being the largest, the little tap root terminating less abruptly than in the others. Triumph is of medium size and very attractive appearance, the white color being overlaid with horizontal stripes and splashings of a deep pink color. Will last for a considerable length of time before turning pithy. The other varieties tested are:

Improved Chartiers or Shepherd.—Nearly as early as the last, but with a longer season. Oblong in shape, crimson colored and of excellent quality.

Stuttgart Early White Giant.—A medium late sort growing to very large size, but being at its best when two to three inches in diameter. Greyish white, turnip-shaped, with very long tap root; quality fair.

Icicle.—A medium early variety. Long, slender roots with a delicate white color. Mild, brittle and very juicy; none better for quality.

Rose China.—A late variety; club-shaped and partly growing above ground. Of large size, light crimson colored; flesh firm and somewhat dry, but mild and crisp. Packed in dry sand, it will keep until late winter.

California Mammoth.—A winter radish of large but not overgrown size, with very long tap root. Color dark grey; flesh somewhat leathery but mild and juicy; well adapted for leaving unharvested for spring use.

LETTUCE.

The varieties tested are Deacon or St. Louis, Early White Self-folding, Hanson, Mammoth, Perpignan or Defiance and Colossal.

Early White Self Folding is a late sort belonging to the Cos variety. Heads pointed, very light green and blanching well. The other varieties belong to the close or cabbage head sorts. *Hanson* has the longest edible maturity and the light green curly leaves are very tender.

Perpignan or Defiance is a good variety with dark green and red margined

leaves, the heads being tender and of good size. Both *Colossal* and *Mammoth* form large solid heads with well blanched hearts and very tender.

Deacon or St. Louis is equally desirable for quality, the round, smooth, light green leaves forming small but solid heads.

SPINACH.

Improved Bloomsdale and *Round Summer* ran to seed as soon as edible. The leaves are small to medium sized, light green and of good flavor.

Victoria proved the best of the three, the broad, dark green leaves being much larger, mild flavored and tender.

The two following are described here, not because they are varieties of spinach, but because they are sometimes advertised as "summer spinach" and "spinach beet." Both are varieties of the common beet (Beta vulgaris), the roots being small and not edible. The varieties are Lucullus and Swiss Chard or Sea Kale.

Lucullus is best adapted for "greens," the large moss curled leaves remaining in good condition until the beginning of winter and being tender but without any pronounced flavor. The variety ought to prove valuable as a midsummer vegetable.

Swiss Chard is a stronger growing plant than the last. The leaves are extremely large though not as desirable for "greens." The stems are the better portion of the plant and these are very broad, flat, waxy white and remain quite tender throughout the entire season, being mostly valuable as an early vegetable.

SALSIFY.

Two varieties were tested. *Salsify or Vegetable Oyster* developed into roots of good size, the largest percentage being fairly free from prongs. *Wisconsin Golden* proved worthless, hardly any of the roots attaining a diameter of even half an inch.

KOHL RABI.

The *Early White Vienna* variety was tested, being planted May 30 and edible July 26. Of good flavor and very tender when harvested young. The variety grows to large size but becomes woody long before it is full grown. It deserves more extensive cultivation owing to its hardiness and usefulness for stock food when it is no longer fitted for table use, there being no roots to clean and the leaves remaining tender until the end of the season. Very few were removed for table use, and from three rows four rods long, or three-fourths of a rod square, three and one-fourth bushels were harvested at the end of the season, the yield showing a possible harvest of nearly 700 bushels per acre.

ONIONS.

The bulbs from seed did not ripen as well as those from sets owing to the fact that the former require a longer season for maturing, and while small, are damaged to a greater extent by the seemingly ever present onion maggot. The white varieties, whether from seed or sets, ripened earlier than either the yellow or red, and those known as "multipliers" ripened earlier than the ordinary varieties in general use. Of the varieties tested, the following are worthy of note:

German Salad.—Raised from sets. A yellow variety of good size and elongated pear shaped; of mild flavor and stands close planting. Slow to cure owing to the thick necks.

Large Red Whetherfield is the only variety which thoroughly ripened from seed. The bulbs are of good size and fair shape.

Long Keeper.—Pale red, medium size, and better shape than the last. Did not ripen sufficiently.

Steward's Pineapple.—A pear-shaped variety of some merit. Ripened least of any variety.

Early White Welsh.—Did not develop any bulbs, the variety being evidently adapted for bunching only, and as such is decidedly valuable.

LEEK.

Monstrous Carentan.—Mild flavored and tender. Was slow in developing, and remaining undersized, did not require but little banking up for bleaching.

CHIVES.

The slender awl-shaped leaves are extensively used for flavoring by those who appreciate its mild onion flavor.

GARLIC.

The white, clustered and pointed bulbs are used for meat and sausage flavoring and are more extensively used by Mexicans and those of Spanish origin, though there is a steady and limited demand for it by Germans in northern markets. Of powerful scent and never-to-be-forgotten flavor.

CELERIAC.

The variety *Giant Prague* was tested. Most of the plants set out on well drained ground developed very large, smooth bulbs, while those planted on better but poorly drained soil, remained undersized.

CABBAGE.

A portion of the ground upon which the plants were set out proved to be badly infested with cut worms and over 90 per cent of the plants were destroyed before the worms could be even partially subdued. Scarcely any worms could be found upon the rest of the plots which were laid out upon low ground. These plots have been used for cabbage and celery during the past three years and would be well adapted for these crops if properly drained. Wet as they are even during dry spells, the maturing of the late varieties of cabbage is considerably retarded, though the early varieties have not apparently suffered at any time except that the mature heads are invariably smaller upon the lowest portion of the plots. The following varieties were tested:

Early Jersey Wakefield.—The pointed shape of the heads is the only objection to this variety. The solid and early ripening heads are unsurpassed for quality, though not equal to the Savoy cabbages for delicate flavor.

Filderkraut.—Heads conical and very pointed. Pale green and whitens well when maturing. A medium early variety with heads very firm. Somewhat coarse and tough for cooking, though for sauerkraut this may possibly be a desirable feature.

Marblehead Mammoth Drumhead.—Heads medium to large, round, slightly flattened and closing fairly well on top. Most of the heads remained soft.

Danish Ballhead.—Form globular and size small to medium, the heads being very firm and of a bluish green color, while the quality is excellent. Probably the best market variety.

Giant Red Dutch.—Small but very solid heads, which like the last will keep in excellent condition for several months. Though the market for red cabbage is limited, their good quality should recommend them for general cultivation on a small scale.

Improved American Savoy.—Small to medium size and nearly globular shape. Most of the heads were very firm and of best quality.

CAULIFLOWER.

Surehead.—A few very large heads were secured, and though the rest were small, they were of excellent quality.

White Mammoth Broccoli made a very rank growth, but no heads formed.

HERBS, ORNAMENTALS AND MISCELLANEOUS CROPS.

PARSLEY.

Champion Moss Curled.—Ease of cultivation, hardiness, pleasant flavor and ornamental qualities are features which should recommend Parsley as an indispensable addition to the kitchen garden The variety tested is useful as flavoring while young, and for garnishing throughout the entire season.

MUSTARD.

Southern Giant Curled.—The crimped and much curled leaves are very ornamental and well adapted for "greens." The plants did not develop until late in the season.

TOBACCO.

Two varieties were tested, the plants being set out June 20, and partially destroyed by cut worms.

General Grant blossomed August 6 and the seed ripened. The leaves averaged 27x17 inches.

Connecticut Seed Leaf blossomed August 16, the seed not ripening sufficiently. The leaves averaged 30x15 inches.

PEPPER.

Two varieties were tested, the plants being set out June 20. The plants were more or less defoliated by cutworms and several died from the damage. Those least damaged of the *Red Cherry* variety ripened nearly all their fruit, blossoming July 7. The peppers are very pungent, much larger than cherries and are conical shaped. The plants bear profusely, and when late in the season they are loaded with blossoms and peppers in all stages of ripeness, their varied and brilliant coloring renders them very conspicuous and highly ornamental.

Ruby King blossomed July 10 and produced large green peppers none of which ripened.

CASTOR OIL PLANTS.

Two varieties were tested, viz.: *Castor Oil Bean*, the common green leaved variety (*Ricinus Communis*) and *Ricinus Sanguineus*, with dark brownish red leaves and stems. Of 50 seeds planted June 8 and all of which sprouted and partially developed, there remained six plants which blossomed August 2, the others being destroyed by cutworms. It seems certain that the appetite of cutworms is not restricted by taste, and though the destruction by them of castor oil plants may be an occurrence without precedent, it will seem anything but strange in this instance, considering the insect's previous diet of red pepper and tobacco.

CHICORY.

Large Rooted Magdeburg.—Planted June 8, some very large roots of even size were secured. The plants are extremely hardy, hence well adapted for this latitude.

CHUFAS.—(*Cyperus esculentus.*)

Sometimes called earth almonds. One of the sedges cultivated in the southern states for the edible tubers, which somewhat resemble, but are much smaller than the Jerusalem Artichoke. Planted June 8, numerous tubers developed, none being larger than an ordinary hazel nut. The plants did not blossom and the tops were not damaged by the September frosts.

SCOLYMUS.

Said to be a species of the Globe Artichoke (*Cynara scolymus*), the flower heads of which are edible. The variety *Cynara Cardunculus*, known as Cardoon, is cultivated for the fleshy leaf stalks and midrib which are blanched like celery. The true name of Scolymus as tested here could not be ascertained at this time; the root being the edible portion of this variety. The thistle-like leaves are moderately pinnatified with numerous prickles, the color being pale green with white stripings. The roots grow as large as those of Salsify, have the same milky sap and are of excellent flavor. Edible early in September and probably earlier during a warmer season. Appears to be quite hardy and should prove to be a valuable acquisition as a late summer vegetable.

Cynara Scolymus or *Globe Artichoke*, was planted June 8 for the purpose of testing the hardiness of the plants when left unprotected during winter. The plants were green at the end of October when nearly all other vegetation had either been killed or seriously damaged.

Honey Anchusa, determined by Prof. B. O. Longyear as *Anchusa Italica*. An ornamental plant said to be valuable as a honey plant. For attracting bees and kindred insects it has few equals, the delicate colored blossoms resembling Forget-me-nots, being borne in profusion on the many stout branches. The plants reached a height of 28 inches, blossomed until late in October and were not entirely killed by the killing frost of October 24.

SMALL FRUITS AND ORCHARD.

Under more adverse conditions, the behavior of strawberries was fully as satisfactory as during previous seasons, for while some varieties yielded less, others yielded more.

Among the gooseberries, Houghton, Downing, Pearl and Red Jacket, in the order named are the most profitable varieties, for while the other varieties on trial appear to be fully as hardy, they have not been as able to resist the attacks of mildew nor seem to derive any benefit from spraying with potassium sulphide. Perhaps the extreme wet condition of the soil induces the periodical spread of this disease, and other varieties may prove to be valuable when with more land cleared, the bushes can be grown upon higher ground.

The raspberries continue to bear a small crop. The bushes each season give promise of large yields until the first fruit begins to ripen, but the canes dry up before the picking season is over, and in this respect no perceptible difference could be noted between this, a wet season, and the previous dryer season, nor could any disease or insects be observed upon the canes during either season. Eldorado, of the blackberries behaved in a similar fashion, while Erie, as during the previous season, continued to blossom until late August setting little fruit.

Although first in blossoming and being regularly damaged by frost when the berries are one-half to two-thirds full grown, the red currants, especially the North Star, bear a fair crop. Currant worms during the past season appeared in amazingly large numbers and were not entirely subdued after four sprayings with hellebore.

STRAWBERRIES.

Observations taken in 1902 were continued during May and June, 1903, when the strawberry plants were in blossom, the object being to ascertain more fully, first, whether blossoms are immune against not only severe frosts, but even such as are commonly termed as killing frosts, i. e., 26 degrees; second, whether such immunity, if existing, is due to heat previously stored up in the soil and liberated during frosty nights.

For this purpose, two self-registering minimum thermometers were fastened upon a post which had been erected in the center of the strawberry plots, the plots being located upon ground approximately 45 feet lower than that upon which is erected the instrument shelter containing the thermometers for taking the daily weather observations. One of these two thermometers was fastened upon the post four and one-half feet above ground, the other six inches above ground. Observations were first taken May 29 when all varieties were either in blossom or with the fruit buds well developed. Several blossoms were marked by loosely tying a short piece of white twine below the calyx and a few buds nearly ready to open were marked in a similar way, small stakes being driven in the ground alongside of all thus marked. As will be seen below, the frosts were not only as heavy as in 1902, but they were more numerous, and coming later, were calculated to be more damaging. While this greater damage is made manifest by the reduced yield of some varieties, the fact that the total yield of all varieties was equal to that of the preceding season, would warrant the conclusion that the strawberry, though more cosmopolitan than any other fruit, is better adapted for northern than for southern latitudes, since highly profitable crops can be raised in spite of frosts which not only are termed as killing frosts but which in southern latitudes would unquestionably destroy most vegetation. This conclusion would seem further warranted by the fact that the early varieties give the best yields, while the lower yields are obtained from most of the varieties least subject to frosts but ripening their fruit during the warmest portion of the season. The following is a record of the temperatures:

Date.	In shelter.	On post 4½ feet above ground.	On post 6 inches above ground.
May 29	30	26	28
" 30	25	21	23
" 31	29	25	27
June 1	29	24	26
" 2	32	27	30
" 3	34	31	32
" 4	38	35	36
" 5	42	39	39
" 12	26	22	22
" 13	32	29	28

The above figures indicate, first, that the higher ground is warmest at all times during frosty nights; second, that the soil gives off sufficient heat to elevate the temperature immediately above it from one to three degrees; third, that during continuous cold weather heat is rapidly driven off from the soil until finally the coldest temperature is that immediately above ground.

Of the blossoms and buds marked, none were damaged until June 12, when all had developed into fruit from one-quarter to two-thirds full grown. Only two failed to show any signs of damage on June 13, and these two subsequently dried up. Though all were thus killed by the frost of June 12, the fact remains nevertheless, that thousands of others which had not been marked were not affected by any frost, since the berries were ripe a week later. It is possible, even probable, that the more or less reclined position of the blossoms of certain varieties, may in some measure contribute more or less to their immunity from frosts. The observations of the past two seasons however, would rather indicate that such immunity is due to a specific cell structure, innate or acquired, and known as hardiness. The fact that blossoms were not damaged previous to June 12 would also indicate that partly grown fruit is more tender than blossoms. During the coming season, observations will be taken for the purpose of ascertaining the value of mulches as a protection against the latest frosts.

When considering the yields in the following table, it should be remembered that the plots are still in the extreme wet condition heretofore described. In the following table the yield per acre is given for 1902, as well as 1903, in order to compare the probable effect of frosts upon certain varieties. As shown in Special Bulletin No. 20, the spring frosts in 1902 were fewer and probably less damaging to early varieties, since the last frost occurred a week earlier and was less severe.

TABLE OF STRAWBERRIES (In matted rows 4 feet apart).

Yield of plot, in qts.	Varieties.	Sex.	Length of row, in feet.	First blossom.	First ripe fruit.	Last ripe fruit.	Yield per acre, in quarts, 1903.	Yield per acre, in quarts, 1902.
147	Bederwood	Perfect	460	May 13	June 23	July 24	3,480	4,344[illegible]
21	Brandywine	Perfect	200	" 25	July 9	Aug. 1	1,143[illegible]	1,279[illegible]
27	Bryant	Perfect	180	" 24	" 6	July 21	1,633[illegible]	1,149[illegible]
9½	Bubach	Imperfect	100	" 23	" 3	" 20	1,034[illegible]	1,089
40	Clyde	Perfect	570	" 17	" 2	" 24	764 1-5	1,299[illegible]
146½	Excelsior	Perfect	1,520	" 12	June 22	" 21	1,049[illegible]	1,117[illegible]
19	Gandy	Perfect	135	" 27	July 8	Aug. 1	1,532[illegible]	1,855[illegible]
3½	Glen Mary	Perfect	30	" 26	June 27	July 23	933[illegible]	544[illegible]
129	Haverland	Imperfect	460	" 24	" 25	" 24	3,054	2,450[illegible]
2½	Marshall	Perfect	95	" 24	July 2	" 28	286[illegible]	114[illegible]
8½	Mayflower	Perfect	135	" 13	June 24	" 21	685[illegible]	484
7	Michigan	Perfect	760	" 29	July 11	Aug. 1	100[illegible]	222 1/10
57	Parker Earle	Perfect	580	" 24	" 4	July 24	1,070[illegible]	1,107[illegible]
309½	Sample	Imperfect	1,140	" 26	" 4	Aug. 1	2,957[illegible]	2,641[illegible]
27	Seaford	Imperfect	180	" 24	June 27	July 24	1,633[illegible]	544[illegible]
3	Success	Perfect	380	" 17	" 26	" 22	1,060[illegible]	1,046

In 1902, plants from the twelve varieties named in the following table, were set out north of the orchard, in order to notè their behavior when growing upon well drained, sandy loam. A single row three rods long was planted to each variety, the rows being four feet apart and the plants eighteen inches apart in the row. Numerous plants, especially of Michigan and Sample, proving worthless and having evidently been taken from the ends of runners, were subsequently destroyed, thus leaving some of the rows, especially the last two, not as well filled out at the end of the season as some of the others. The first fruiting of the varieties is shown in the following table, the results being mainly conspicuous for earlier blossoming and fruiting due to the higher and warmer soil. As the timber stands within a rod north of the plot, the berries were soon discovered by chipmunks and cedar birds, and the results which are negative with three varieties, were probably more or less affected from the same cause, at least as far as the late ripening varieties is concerned. Further trials are necessary in order to determine the preference of the varieties for one or the other kind of soil, though as far as Excelsior is concerned, the plants showed such rapid and very marked improvement as soon as transplanted, as to make it quite certain that the increased yield is due to the lighter soil.

TABLE OF STRAWBERRIES PLANTED ON SANDY LOAM (in matted rows 3 rods long and 4 feet apart).

Varieties.	Date of blossoming.	First ripe fruit.	Last ripe fruit.	Yield of plot, in qts.	Yield per acre in qts.
Bederwood	May 11	June 20	July 22	10½	2,310
Brandywine	" 22	" 27	" 31	8½	1,870
Clyde	" 14	" 23	" 26	10½	2,310
Excelsior	" 9	" 16	" 18	15½	3,410
Gandy	" 29	July 6	....	0	0
Glen Mary	" 21	June 25	July 29	9½	2,090
Haverland	" 20	" 23	" 23	19	3,960
Marshall	" 20	" 26	....	0	0
Michigan	" 30	July 4	....	0	0
Parker Earle	" 22	June 28	July 31	5½	1,210
Sample	" 23	" 30	" 31	8	1,760
Success	" 19	" 26	" 26	6½	1,430

ORCHARD.

No disease proved troublesome during the season, apple scab yielding readily to judicious spraying, though pear scab seems hard to control with the Flemish Beauty, but appears to be confined to this variety only. Even though wet seasons are more favorable for the spread of fungous diseases, shot-hole fungus and leaf spot of the cherry never before yielded so readily to Bordeaux mixture, requiring but two sprayings during the season, the result being perhaps due to the greater amount of lime which had been added to the copper sulphate, being 50 per cent more than the usual quantity for the first spraying and 30 per cent more for the second spraying. This increase was deemed advisable owing to the wet weather, and the effect of even the earliest spraying could still be noticed upon some of the leaves towards the end of the season.

No insects proved troublesome except several species of aphis. Owing to the persistent warfare waged against it during the preceding season, the cherry beetle (Calerucella cavicollis) could not be found until mid-season, those which then appeared being evidently stray individuals reared on the wild cherries in the neighboring woods. Basilarchia arthemis (banded purple) were found upon most of the apple trees at the beginning of the season, but in greatly reduced numbers when compared with the preceding season. The black aphis of the cherry, never before seen here, made its first appearance early in August and the green aphis of plum trees were exceedingly numerous early in season. The apple tree aphis were hardest to control and did not appear to be materially reduced after three sprayings with tobacco water and two with soap water, but finally yielded to a combination of the two spraying mixtures, one pound of tobacco

stems and one pound of hard soap being used for eight gallons of water.

High winds maimed and destroyed a number of trees, the greatest damage being done to all plum trees with a spreading or drooping habit of growth. As this damage occurs more or less each season, there are now but very few uninjured trees left in the plum orchard, though none of the Shrop Damson or Moore's Artic have been affected, owing to their compact habit and their shorter limb growth.

A very heavy yield of the cherry trees was reduced to a minimum by the frost of June 12, at which date the fruit of all varieties had attained various stages of development. None of the previous frosts proved damaging though the blossoming season began May 20. The English Morello was a noted exception, the little trees remaining well loaded and ripening a fair crop. A single tree of the Wragg variety was another exception and ripened a full crop possibly owing to the fact that the buds having remained dormant, the tree was finally stimulated into activity by an application of nitrate of soda, bone meal and wood ashes, and the first blossoms did not open until June 10, the delay thus enabling nearly all blossoms to escape all frosts. Another tree of the same variety acted in a like manner, and being left untreated, dried up as soon as leafed out. One of the Dyehouse cherry trees and one of the Hawkeye plum trees died in a similar manner. Investigation showed these trees to be dead about two inches above and two inches below the point where the scion was grafted into the root, while the body of the trees and the root system were healthy, the dead portion being considerably larger in diameter than the body of the tree and being abruptly tapered upwards, indicating that the root had been growing faster than the tree, though these trees were uncommonly large for their age. Two more varieties of cherries came into bearing:

Lutovka.—A large, strong, upright growing tree with branches somewhat spreading. Blossomed May 28, and fruit ripened August 2. The cherries are light red, translucent, juicy, slightly acid and of good quality. Size medium to large, oblate, somewhat heart-shaped with wide and deep cavity and stem averaging one and one-fourth inches.

Vladimir.—A small but stout growing tree with round shape. Blossomed May 25, and ripened fruit July 25. Fruit medium size, round, very dark red. Flesh dark red, melting, sub-acid, slightly astringent and of good quality. Cavity shallow with long slender stem, averaging one and one-half inches.

The scarcity of fruit buds of these two varieties is apt to show that both may prove to be shy bearers. The plum trees were damaged by frosts more than the cherries, the latest varieties being in blossom May 30. The fruit which remained on the trees of several varieties did not ripen thoroughly, remaining in a partly ripe condition from early September until damaged by frost at the end of October.

The grape vines showed much improvement during the season, the new growth of some canes exceeding seven feet. To protect the young shoots against spring frosts small boxes were inverted over the plants during frosty nights and this gave ample protection. One vine of the Moore's Early variety ripened fruit, blossoming July 4, the bunches being small to medium size and the berries remaining somewhat sour.

One tree of the following varieties of apples came into bearing:

Gideon, blossomed May 24.

Haas, blossomed May 27.

Yellow Transparent, blossomed May 31.

Borowinka, blossomed June 5.

The apples were too few in numbers and the trees are too young to give an accurate description of the varieties at this time.

ADDITIONAL WORK UPON THE ASSOCIATIVE ACTION OF BACTERIA IN THE SOURING OF MILK.

BY CHARLES E. MARSHALL.

[Special Bulletin No. 29.]

In the first article of these studies published in the Centralblatt für Bakteriologie, II. Bd. XI No. $^{24}/_{25}$ and as Special Bulletin No. 23 from Michigan State Agricultural College Experiment Station, there was demonstrated conclusively by repeated experiments, the influence of a distinct species of micro-organisms, diametrically opposed in its nature and functions to lactic acid bacteria, upon the souring of milk. In this article, as in the previous discussion, the micro-organisms will be designated in the same manner—that micro-organism, which peptonizes the casein, after a time renders the milk quite alkaline, and is employed for association with the lactic acid bacterium, has been and still continues to be designated by B, and the lactic acid bacterium by A.

Since recording the first work some fifty tests have been independently made by as many individuals, all of which tends to strengthen the writer's position in this matter. Farther than this, other micro-organisms which may be classed in general with B have been met which are capable of producing similar results when associated with A in milk, and also others which do not hasten the souring of milk or stimulate the activity of the lactic acid bacteria, but on the other hand, retard or check the souring process. Very dissimilar processes are met, each individually characteristic, yet all deviate in one way and another from the simple process of milk souring in a pure milk culture of lactic acid bacteria designated as A. In this connection therefore two groups present themselves—those which hasten the souring of milk and those which retard. At this stage of our work it cannot be stated which is the predominating group. As far as the investigations go, that which hastens the process is in the ascendency and the amount of influence exerted is widely varying.

The immediate cause for this stimulating influence upon the lactic acid bacteria through the development of a species of micro-organism, so different in its effect upon milk and in its nature, calls for consideration. The fact that micro-organism B usually dies out within fifty hours when associated with micro-organism A in milk, indicates that the influencing factor must be the outcome of the first hours of development. Micro-organism B predominates at first but is superseded by A, hence micro-organism B probably produces this factor. If this factor or substance be stable and remain unchanged by heat, it follows that the substance would yield to sterilization and could be used independent of the germs producing it. In accordance with this view, micro-organism B was cultivated in sterile litmus milk culture for forty-eight hours at 23° C., when it became apparent that a change had begun in the milk. The cultures were then heated in steam for three consecutive days, at the end of which time bouillon culture tests made from the milk established the fact of sterility. Sterile litmus milk flasks, from the same lot of milk used for the above cultures of micro-organism B, and containing the same amount of milk in each, were inoculated with micro-organism A in identical amounts as were inoculated into the set of sterilized flask cultures in milk as described. These two sets of flask-cultures, one set in which micro-organism B had grown for forty-eight hours then sterilized and inoculated with micro-organism A, the other set simply inoculated with micro-organism A, were placed at 23° C. and observed from time to time. It was found that micro-organism B had in some manner produced a substance or condition which remained unchanged through sterilization and was apparently as active in stimulating the lactic acid bacteria as the living micro-organisms themselves. To further test this product of

micro-organism B, some whey-agar was made out of a milk-culture of B which had grown for forty-eight hours. The casein was precipitated by rennet, the whey was clarified and made into agar. When this agar was planted with micro-organism A and the culture compared with the growth upon whey-agar made from fresh milk, in twenty-four hours time at 37½° C., there was so much difference in the prolificacy of growth manifested between the two whey-agars in favor of the agar made from the milk-culture of micro-organism B that it was plainly evident the products of micro-organism B found their way into the agar. The stability of these products through repeated heating is only another instance of what has been repeatedly demonstrated in case of many other products of bacteria.

In an effort to secure definite data upon the influence of the products resulting from the growth of micro-organism B in milk, a quantitative determination was resorted to. Eight flasks, 500 c. cm. in capacity, were employed as containers. Into each was placed 100 c. cm. of milk of the same lot, to which litmus had been added. These were heated at 100° C. for three consecutive days. For the purpose of reference we shall designate these flasks as 1, 2, 3, 4, 5, 6, 7, and 8. When sterilization was completed, flasks 5, 6, 7, and 8 were inoculated each with a definite and the same quantity of micro-organism B. These flasks were placed at 23° C. for forty-eight hours, at the end of which time visible milk changes, characteristic of micro-organism B, were noted. They were then heated again at 100° C. for three consecutive days. Bouillon tubes inoculated from these flasks gave no signs of growth after several days. At this stage, therefore, we have four flasks, 1, 2, 3, and 4 in which no special germ had been permitted to grow, and four flasks, 5, 6, 7, and 8 in which micro-organism B had been allowed to develop for forty-eight hours at 23° C.

Each of these flasks, 1, 2, 3, 4, 5, 6, 7, and 8, was inoculated synchronously with 1-2000 c. cm. of a fresh milk-culture of micro-organism A. An estimated determination made the number of organisms 49,800 for each flask. In handling this amount of culture, to obtain accuracy and uniformity, high dilutions in physiological salt solutions were employed. Our work was accurate, for the eight plates employed scarcely deviated over one or two colonies from the average. The further results of our work also bear us out in the correctness of our manipulations.

All the flasks after inoculation as above were placed at a temperature of 23° C. Observations were made every twenty-four hours.

Observations at the end of twenty-four hours.

The litmus in the milk in flasks 1, 2, 3, and 4 was slightly reddened only. There was no apparent change in milk. In flasks 5, 6, 7, and 8 the litmus was wholly reduced except a very thin layer on the immediate surface. The milk was a firm lopper with whey separated.

Observations at the end of forty-eight hours.

Litmus in milk in flasks 1, 2, 3, and 4 redder than twenty-four hours previous. Milk still unchanged to naked eye. Flask cultures 5, 6, 7, and 8 remained as the day previous. Growth was checked and oxygen had permeated milk to half its depth, reddening the litmus.

Observations at the end of seventy-two hours.

Milk in flasks 1, 2, 3, and 4 was beginning to lopper. A thin layer of loppered milk had formed on bottom of flasks but surface milk was still fluid. Litmus almost wholly reduced. Flask cultures 5, 6, 7, and 8 remained same as previously; the litmus had become red throughout.

Upon reviewing the above observations, it should be emphasized that flasks 1, 2, 3, and 4 developed together as nearly identically as it is possible: a study of the acidities will also establish this; hence it follows that these four flasks may be considered as demonstrating the unity of action. Flasks 5, 6, 7, and 8 may also be treated in the same manner. The difference in time of loppering between these two sets is about forty-eight hours. Flasks 5, 6, 7, and 8 were thoroughly loppered and the whey separated in twenty-four hours, while flasks 1, 2, 3, and 4 did not begin to lopper till seventy-two hours. Flasks 1, 2, 3, and

4 were wholly free from and uninfluenced by micro-organism B, while flasks 5, 6, 7, and 8 had in reality been cultures of forty-eight hours standing of this micro-organism. Since the germs had been killed by sterilization, we may conclude that the products resulting from their growth furnished a more favorable medium for the development of the lactic acid bacteria, causing the more rapid souring of the milk.

An investigation of acidity in these flask-cultures at intervals of twenty-four hours will also offer conclusive proof and a more intimate knowledge of the changes taking place. At the time of inoculation of these milk flasks with micro-organism A, flasks 1, 2, 3, and 4 had an acidity to phenol-phthalein of 22°, flasks 5, 6, 7, and 8, of 26°. This difference of 4° may be attributed to the action of the products of germ B upon the indicator phenol-phthalein. This has been noted before. The difference is apparent, therefore, and not real. Litmus remained blue and became more densely blue as micro-organism B continues in its growth in milk. Moreover these four degrees will have little effect upon the striking results obtained.

Flask-cultures	0 hrs old.	24 hrs. old.	48 hrs. old.	72 hrs. old.	96 hrs. old.
1	22°	30°	48°	62°	66°
2	22°	30°	46°	60°	66°
3	22°	30°	48°	62°	64°
4	22°	30°	48°	62°	66°
5	26°	72°	108°	112°	112°
6	26°	72°	106°	112°	110
7	26°	70°	108°	112°	110°
8	26°	70°	108°	110°	110°

The slight differences in the readings in each set at the same hour are easily attributable to experimental error; however, the wide difference in acidities existing between the two sets, flasks 1, 2, 3, and 4 on the one hand, and flasks 5, 6, 7, and 8 on the other, clearly indicate that some influence is at work which has the power of increasing the acidity rapidly in flasks 5, 6, 7, and 8 over flasks 1, 2, 3, and 4. All are identical in their treatment and conditions, excepting the products which are under discussion. These products alone can account for these results. Heretofore I have called attention to the uniformity in the development of the cultures. This is very noticeable in the study of acidities and such uniformity lends confirmation to the work.

But one feature more remains in this discussion to bring it up and make it harmonious with my former article for purposes of comparison and that is the consideration of the number of bacteria developed in flasks 1, 2, 3, and 4 of one set, and also in flasks 5, 6, 7, and 8 of the other. I have already stated that at the beginning, each flask contained 49,800 micro-organisms A. The time for ascertaining the necessary comparison in the number of germs was determined by the loppering of the milk in flasks 5, 6, 7, and 8; at this point a comparison, forsooth, is far more desirable than at any other point. A careful estimate reveals 12,920,000 micro-organisms per c. cm. in flasks 1, 2, 3, and 4; and 517,920,000 micro-organisms per c. cm. in flasks 5, 6, 7, and 8. This estimate was made at the end of the first twenty-four hours after the inoculation of the milk with micro-organisms A. The ratio existing may be stated as follows—the number of micro-organisms A in flasks 1, 2, 3, and 4 without the influence of micro-organisms B is to the number of micro-organisms A in flasks 5, 6, 7 and 8 growing under the influence of the products of micro-organism B as 27: 156. It is therefore conclusive that the lactic acid bacterium grows more rapidly in the presence of the products of micro-organism B than when it is not so associated and that milk sours more rapidly when either the living form of micro-organism B or its products are present. This is due to the influence exerted by micro-organism B directly or indirectly upon the development of micro-organism A. The evidence is three-fold: 1st. It is manifest from the apparent changes in the milk on mere observation. 2nd. It is manifest by a study of the development of acid in the different flasks. 3rd. It is manifest by the number of germs actually found to be present in the different cultures.

In our former article we succeeded in establishing that micro-organism B influences micro-organism A in the souring of milk, in this article we have

brought this influence down to the products of micro-organism B.

This work has a direct bearing upon the pure milk supply, because as soon as these micro-organisms possessing the nature of micro-organism B are allowed to grow in milk during the first hours after milking there is always that possibility of products forming which may be obnoxious and which may hasten the souring of the milk. This work also has its bearing upon the use of starters because we are able to show, and shall show in a future article, that the products of micro-organism B are stable and cannot be supplanted by any starter. Butter made from cream so treated will show a diminution of the products of culture B in proportion to the amount of acid starter employed in covering up its products. The persistency of the products of micro-organism B also indicates that there is but one way to secure absolute results in milk products: this consists in establishing as cleanly conditions as possible and at the same time cooling the milk down to that degree which will retard the development of these obnoxious micro-organisms. Other results are becoming more apparent as we proceed with this work but at this time we feel it desirable to limit ourselves to these statements.

REPORT OF SOUTH HAVEN SUB-STATION FOR 1904.

BY T. A. FARRAND.

[Special Bulletin No. 30.]

PROF. L. R. TAFT, *Horticulturist.*

SIR:—The following report upon the work of the South Haven Sub-Station, for the year 1904, is herewith submitted:

The past winter was one of exceptional severity and length, and a number of peach trees were lost from root freezing. The damage was greatest among the older trees that had not recovered from the cold winter of 1898-1899. The trees leaved out, bloomed full, and the fruit set, but within a few days, upon those worse affected the foliage dried up and upon examination, they were found to be dead. Others that did not show it at first, died during the season. While the loss was small in the four-year old block, there are many trees that will never recover. No other kinds of fruits suffered apparent damage.

The older plantations of raspberries and blackberries were getting too old to give good results, and were taken out, and a new planting of peaches was started on this ground. A new raspberry and blackberry plantation was started where the old peach trees had stood. In both instances the ground was covered with manure and plowed under. The raspberry and blackberry plants made a fine growth, and most of the peach trees did well.

All kinds of fruits bloomed full, and the crop of apples, pears and plums was exceptionally good, considering the heavy crops of 1903. Grapes were a heavy crop; peaches and cherries light, with good crops of currants, gooseberries, raspberries and strawberries, although the yield of the strawberries and raspberries was shortened considerably by the severe drouth which came in the latter part of May and lasted until August. With the long continued dry spell, and the crowded condition of the trees on the Station grounds, very frequent and shallow cultivation was necessary to save the trees and fruit from damage.

The results in spraying for fungi and destructive insects were generally good. The second brood of codling moth did more damage than in former years. With the heavy crop of fruit, and crowded condition of the trees, it was impossible to do the work thoroughly, and many trees did not receive the last spraying which has usually been given about the 25th of July. However, some

of the trees were not so crowded, and the fruit and foliage were thoroughly covered with the spray mixture. In these instances the damage was noticeably less than where the trees did not receive the late spraying. The dust spray was again given a very thorough test on the Station orchards with practically the same results as were obtained last year. Duplicate and comparative tests were started in an apple orchard near the Station, but the fruit mostly dropped off, after blossoming, and little in the way of definite results was obtained.

With the appearance of San Jose scale in the orchards in different sections of the fruit belt, it was thought best to secure the co-operation of interested growers and carry on spraying experiments to determine the most satisfactory way of controlling this insect. The experiments were started with special reference to answering the many inquiries regarding the efficiency of caustic soda recommended by California parties as being cheaper and more effectual than the lime, sulphur and salt wash which has been used to fight the scale. The following parties kindly consented to co-operate in the experiment: Mr. Fred Ruell, Kibbie, Mich.; M. F. Burgett, Berlamont, Mich.; Dr. F. B. Samson, Benton Harbor, Mich.; and Mr. J. Hoppenroth, South Haven, Mich. The following scheme for carrying out the work was sent to each party:

Select fifty trees of medium size, upon which the scale is evenly distributed. Thin out the heads, and cut back the branches somewhat more than in ordinary pruning, in order to simplify the work of spraying. Divide the trees into five plots of ten trees each, to afford equal conditions. Spray the trees with the following materials:

Plot 1.—Twenty-five pounds of lime, fifteen pounds of sulphur and eight pounds of salt, prepared as follows: Place twelve gallons of water in a large kettle and boil. Make a paste of the sulphur, and two gallons of the water and add this and twenty-five pounds of lime to the ten gallons in the kettle. Stir while it is slaking and boil for one hour; then add the salt and boil fifteen minutes longer. Place in a barrel for spraying, and dilute to fifty gallons, making the water warm enough to give the mixture a temperature of about 120 degrees.

Plot 2.—Use the same preparation as above, leaving out the salt.

Plot 3.—Use the same material as in No. 1, (lime, sulphur and salt) and prepare as above without boiling after the lime is slaked, that is bring the twelve gallons of water to a boiling point, and use as directed above, but rely upon the heat generated in slaking the lime to cook the mixture. As soon as the lime is slaked and the salt dissolved, place in a barrel, cover, and allow to stand for an hour and a half, then dilute as above.

Plot 4.—Prepare the sulphur and lime as for plot 3 and substitute six pounds of caustic soda for eight pounds of salt; otherwise prepare and handle it as in plot 3.

Plot 5.—Dissolve six pounds of caustic soda and slake five pounds of lime. Use in fifty gallons of water.

The spraying was done in the early part of April. The conditions for carrying out the experiments were as nearly equal as could be found and as the results were nearly identical in all instances, it would indicate that the work was thoroughly done. The sprayed orchards were examined July 14th to 16th. The conclusions were as follows:

It is time and money thrown away to use caustic soda at the rate of five pounds to fifty gallons of water to control the San Jose scale, and to use it stronger is dangerous to man and beast. Thousands of living scale were found upon the trees treated with the above formula, while upon the trees sprayed with the other formulas, the scale could not be found. There was no difference in the different methods. It is evident from the results of these experiments that it is the combination of lime and sulphur that destroys the scale, and that the addition of copper sulphate, caustic soda and other materials is an added expense and brings no better results.

To what extent the boiling and the length of time the mixture is boiled, enter into the destructiveness of this wash, we do not know, except that the boiling caused by the slaking of the lime, as used upon plot 3, gave the same results as in plot 1, which was cooked for one hour. With the large amount of spraying which will be necessary to control this insect in the future, it is highly important that a remedy be found that will be effectual and at the same time easy to prepare and apply. Lime, sulphur and salt, using twenty-

five of lime, fifteen pounds of sulphur, and eight pounds of salt, to fifty gallons of water, boiled one hour, will destroy the scale, and the concensus of those carrying on the experiment was, that the above formula, boiled in the usual way, was the most satisfactory way of preparing the wash, as the water must be hot to get the best results. When the mixture cooled, the pump did not work as well as when boiling hot, nor did it cover the surface of the bark as evenly.

To determine how late in the spring the spraying with this mixture could be done without injury to the buds, a number of tests were made in a peach orchard near the Station grounds. The following formulas were used:

First, lime, sulphur and salt, (25-15-8); second, lime and sulphur without salt; third, lime, sulphur, and five pounds of copper sulphate. The trees were of medium size and full of live fruit buds. Six trees were sprayed with each formula upon the following dates: First spraying, April 25th; second, May 2nd, at which time leaf buds were just showing green; third, May 12th, when the leaves were out but not unfolded and the color showed on all of the blossom buds with an occasional blossom nearly open. The work was very thoroughly done, taking particular pains to drench the trees as though spraying for scale. A few days later the orchard was in full bloom and close observation failed to show any sign of injury to the blossoms, the pistils remaining green and healthy with all of the formulas. The edges of the young leaves were slightly burned, but no difference could be detected, and the injury was not serious.

These results go to show that it is perfectly safe to spray peach trees, up to the time the blossoms open, with the lime, sulphur and salt mixture. No better results were noted when copper sulphate was used nor did the addition of salt appear to increase the effect of the sulphur and lime mixture. It would be better to do the spraying earlier, but when it is necessary to spray during the late spring, there need be little fear of injury to the peach buds up to the time the blossoms open.

The Owen Process.

This so-called process, named after the originator, was claimed to be a specific for all destructive insect pests and diseases that attack fruit or shade trees. While no confidence in the remedy was felt, the agent was allowed to treat a few trees on the Station grounds gratis. The treatment consisted of boring a hole to the heart of a tree and putting in a grayish-black powder, composed largely of sulphur and charcoal, and then inserting a wooden plug. The usual charge for treating a tree was fifty cents, one-half of which was paid down and the rest at the end of the season. All kinds of fruit trees were treated and immunity was promised against insects and diseases of every kind for a period of five years. Up to the present time no effect, whatever, has been noticed and we have no reason to change our original opinion, that the money paid for the treatment by many fruitgrowers was thrown away.

Fall Spraying Experiments.

As a comparative test, to determine which was the best formula for leaf-curl when applied in the fall, a number of trees were sprayed on November 25, 1903, with copper sulphate (two pounds to fifty gallons of water), Bordeaux mixture (4-5-50), and lime, sulphur and salt (25-15-8). Check trees of the same variety where each formula was used were left for spring spraying, which was done April 4, 1904. The fall-sprayed trees showed far less leaf-curl than those not sprayed at all, but there was a slightly larger number of diseased leaves than with the spring spraying. There was no difference between copper sulphate and Bordeaux mixture as applied for leaf-curl in the spring. The lime, sulphur and salt was, if anything, the best for fall spraying, but unless needed for scale, is too expensive to use for this purpose. No injurious effects were noted upon either leaves, or fruit buds, from the use of the sulphur wash in the fall.

To test the effect of a heavy application of lime thick enough to form a coating and thus protect the peach buds during the winter, a number of four-year old peach trees, one of each variety, were sprayed with lime wash as thick as could be applied with a coarse nozzle, adding eight pounds of salt to fifty

gallons. Very close observation failed to show any results either beneficial or injurious to the fruit buds. To determine the fungicidal value of the lime and salt for leaf-curl, these trees were not sprayed when the regular spring spraying was done, and when the foliage came out, no effect of the lime and salt applied in the fall upon the amount of leaf-curl could be detected. Copper sulphate (two pounds to fifty gallons of water) is the best and cheapest remedy that can be applied for leaf-curl, but if the trees are infested with the San Jose scale, the use of sulphur, lime and salt will answer for the leaf-curl as well as for the scale.

STRAWBERRIES.

Owing to lack of space, the testing of strawberries was discontinued in 1899 but forty-five varieties were planted in the spring of 1903. Several varieties were received in poor condition and white grubs did considerable damage, but most of the plants did fairly well and made good fruiting rows. Of the older and standard kinds, fifty plants were set and from twelve to twenty-five of the newer kinds. Late in the fall of 1903, the plants were mulched with coarse straw manure. Early in the spring the mulch was taken off, and a part of it left between the rows. The plants were sprayed with Bordeaux mixture once before blossoming and should have received a second application as soon as fruit had set as the single application failed to entirely control the leaf blight or rust. There were no frosts to injure the crop but the season was late and cold, and towards the end of the blossoming period, it was noticed that a large number of the blossoms of the perfect-flowering varieties were blackened and blasted. Similar complaints came from other points and the cause was laid to the cold, unfavorable conditions of the weather, but the fact that the self-fertilizing kinds were the only ones affected, strongly indicates some other cause. As a severe drouth set in before, and lasted through the fruiting season, the crop was light. After fruiting was over, the rows were cut down to a narrow line of plants; these were cut away, leaving a hill every twelve inches, and commercial fertilizer at the rate of 600 pounds per acre was sown broadcast, and thoroughly cultivated in. Plenty of new runners were sent out, all vacant places were filled in, and the second season's fruiting promises to be far better than the first. A new plantation of seventy varieties was made this spring. It has done very well, and promises well for another season.

Notes on Varieties.

The varieties that gave the heaviest yields were in the order named,—Bederwood, Ernie, Lincoln, Aroma, Dunlap, Brandywine, Glen Mary, Rip Snorter, Clyde, and Seaford, while Marshall and Ohmer gave the smallest yields.

Aroma:—Proved to be the best late-ripening variety on trial. Plants strong, stocky, vigorous and healthy; not too numerous, but strong enough for a good fruiting row. Fruit large, holding its size through the season. Color bright, light red, or scarlet; form, irregular, roundish to oblate-conical, sometimes flattened at the apex; firm for a large berry, with mild pleasant flavor. Handsome and valuable.

Bederwood:—Perfect. This old variety gave the heaviest yield, and stood the drouth the best of any variety on trial but, for all of this, is scarcely worthy of planting. The fruit is of good size but is too soft, light in color, and poor in quality for either home or market.

Bethel:—A mid-season variety, only moderately productive; flowers imperfect; plant stocky, vigorous, and healthy. Berries, medium to large, roundish. oblate-conical. Color bright, dark red, with red flesh. Texture firm, and of very good quality. The fruit ran small after the first picking and was knotty, showing imperfect fertilization.

Brandywine:—Perfect. One of the best mid-season to late kinds. Plants strong, numerous, healthy, and productive. Fruit, large, attractive and very good in quality. Reliable with favorable conditions.

Bryan:—Perfect. Berries large, medium late, and of fair quality. Form, irregular, oblate, ridged. Color, mottled light and dark red. The plants made a vigorous growth but lacked productiveness this season.

Clyde:—Perfect. An old standard variety. Very productive; fruit large, very smooth, regular, and of fair quality, but tender in texture, for long shipping, and fails to color up well. Mid-season.

Corsican.—Perfect. Plant very strong, vigorous, and healthy. Fruit stems stout, but not plentiful. Berries large, irregular, ridged, shaded light and dark red. Medium firm, with a mild pleasant flavor. Mid-season, and only moderately productive.

Crockett:—Perfect. This proved to be an early to mid-season variety which showed but few points of value. It is a strong plant maker, and quite productive, but the fruit is small, pale, dull in color, and of only fair quality. Not valuable.

Dewey:—Perfect. Plants numerous, and tall, strong growers; inclined to rust badly. Berries of medium size, long, conical, necked; color bright, light red, firm; pleasant flavored and of good guality. Mid-season. Not productive.

Dunlap:—Perfect. As a mid-season sort, this variety was the best on trial for either home use or market The plants are strong and healthy. Fruit stems, numerous and hold the fruit well up from the ground. Fruit, medium to large, roundish, conical, necked, smooth, regular. Color a dark, handsome red. Medium firm, juicy, with a rich flavor; fine for table use or preserving.

Elba:—Perfect. Proved identical with Smith. Early, but too small and light in color to be valuable.

Ernie:—Perfect. A new variety, originated by Dr. Maudlin, and introduced by A. R. Weston & Co., Bridgman, Michigan. As a medium late variety, it is very promising. The plants are strong and send out runners enough to make a good row. Fruit-stems plentiful and hold the fruit well up from the ground. Berries medium to large, roundish-conical, necked, very smooth and regular. Color dark, glossy red; texture medium firm, juicy, with rather a brisk pleasant flavor; quality good. Should be tried by all strawberry growers.

Excelsior:—Perfect. Well known as a standard early market sort. The best early kind fruited this season.

Fairfield:—Perfect. Received from A. B. Cole, Bridgeton, N. J. A medium to large early berry, very firm and of good quality; form, irregular, roundish, ridged; color dark red. The yield was light this season.

Gersonda: Imperfect. A late ripening variety, that is productive but it makes far too many plants and the berries run small after the first picking. Fruit, medium-sized, bright red, very firm; roundish, inclining to conic, regular; flavor brisk; sub-acid. A good canning variety.

Glen Mary:—Perfect. One of the best mid-season varieties. The plants are strong, vigorous and healthy, making plants enough for a good row. Fruit-stems strong and plenty of them. Fruit large to very large; roundish, irregular. Firm for so large a berry and of good quality. Valuable for either home or market. Requires the best of care.

Howell—A perfect-flowering mid-season variety, which lacked productiveness. Fruit medium-sized; roundish, irregular. Color dark red; quality good.

Klondike:—A late-ripening variety, with fruit of large size, dark glossy red and quite firm. Form roundish to oblate conic, smooth. Quality fair. A promising late sort.

Lady Franklin:—Imperfect. Plants strong, vigorous, healthy, and good plant makers. Berries medium-sized, inclined to run small and knotty toward the close of the season. Bright red in color and of fair quality. Made a very poor showing here this season.

Lester Lovett:—Perfect. Plant strong, vigorous and healthy, with plenty of runners. Fruit-stems few, fruit large, bright red, firm, and good quality. Similar to Gandy.

LeValley:—Perfect. A mid-season variety, that gave a fair yield of fruit. Plant vigorous, making plenty of runners. Berries medium-sized, irregular, roundish-conic with bright red color. Medium firm, and of good quality.

Lincoln:—Perfect. A strong-growing kind, an enormous plant maker and very productive. One of the varieties whose blossoms blasted quite badly, but in spite of this, it ranked third in productiveness. Berries of medium size: rather dull red; roundish conic, smooth, regular; very firm, with a mild, pleasant flavor. Mid-season to late. Worthy of trial.

Lyon:—Imperfect. Ripens with Excelsior and is productive, but the fruit is small and tender in texture. Form, long-conic, necked; color, dark, glossy red: quality fair. Desirable only on account of its earliness.

Marshall:—Perfect. Of large size, handsome in appearance. Not desirable for preserving. A poor plant maker and subject to leaf-blight. Desirable

when very high culture is given, and a berry of large size and high quality is required.

Minute Man:—Imperfect. Rivals Excelsior in earliness, and productiveness. The fruit runs large, but lacks the firmness of that variety; quality fair. Berries, roundish, conical, regular, with a bright, glossy red. Promising as an early sort.

Mrs. McDowell:—Perfect. A productive, medium-sized, bright red berry, of quite good quality, but very irregular and knotty. Not desirable.

New York:—Perfect. Plant strong, stocky, with plenty of runners; foliage dark green, healthy, quite productive, with very large, handsome, dark red fruit; inclined to be irregular in size and form. Quality very good. Worthy of trial as a mid-season market sort.

Nick Ohmer.—Perfect. A large, attractive berry of good quality, but it lacks productiveness.

Ponderosa:—Perfect. A medium-early sort of some promise. The plants are rather tall and slender; moderately productive. Berries medium-sized, conical, necked, and are of a glossy, dark red color. Firm and of good quality.

Rip Snorter:—Perfect. Plants and fruit-stems strong, the latter extending above the leaf-stalks, when in bloom. This season they were badly blasted, but the variety shows possibilities of being productive. Berries medium to large, roundish, irregular, bright red, very firm; quality good; mid-season.

Rochester:—Perfect. A productive mid-season variety, with fruit of medium size, dark red, firm, rather sour; would make a good canner.

Rough Rider:—Perfect. One of the newer, medium to late sorts; while not as productive as some kinds, the fruit is large, attractive in appearance and held its size well to the last picking. Berries firm, dark red; irregular in form; quality good.

Sample:—Imperfect. One of the best medium to late market varieties. Fruit large, roundish-conic, with a handsome, bright red color. Juicy and of good quality. Valuable.

Seaford:—Imperfect. A medium-sized, medium to late variety that proved only moderately productive. A fairly good variety. Berries large, irregular, long, compressed. Color, a handsome dark red. Quality good.

Sutherland:—Imperfect. Plant a strong grower, sending out plenty of runners; quite productive. Berries medium-sized, of a bright, light red color. Midseason. Inclined to run small toward the last. Not as satisfactory as others of its season.

Smith:—Perfect. An early ripening kind, but too small and light in color to be valuable.

RASPBERRIES AND BLACKBERRIES.

Only two varieties of blackberries were fruited.

Rathbun:—The plants are low, slender, spreading growers, and winter-killed quite badly. Berries medium to large, roundish to oblong, medium firm, sweet; quality good; mid-season.

Mesereau:—Plants strong, stiff growers, and apparently hardy, coming through the winter without injury; fruit medium to large, oblong, moderately firm, and of good quality; mid-season. Worthy of trial.

There was a good yield of raspberries from most of the varieties. Of the blackcaps, Cumberland leads all other varieties in size, appearance, productiveness and vigor. There are, however, many varieties that do well here, and can be safely recommended for planting. Eureka, Gregg, Kansas, Conrath, Mills, Livingston, and Onondaga, have usually given good results and Hilborn, Farnsworth, Centennial, Diamond, and Nemaha are desirable sorts. Diamond and Nemaha are large, late varieties, but lack vigor, while Farnsworth, Centennial and Hilborn are very productive, but the fruit runs small. Eureka is a very good early kind; Kansas, Conrath, Livingston and Mills do well as midseason, while Cumberland, Gregg and Livingston and Onondaga are all good late sorts. Conrath and Gregg are a little more subject to anthracnose than the other kinds, but spraying with Bordeaux mixture, when the young canes are eight or ten inches high, will help to control this disease.

Red Raspberries.

Marlboro is still valuable as a market sort. There are other varieties that are fully as productive but none are larger or more attractive in appearance.

Brilliant, Coutant and Loudon did well. Loudon is valuable if free from root-gall. Brilliant and Coutant are new varieties.

Brilliant is strong, healthy, vigorous and productive. Berries are large and attractive, but of poor quality. Valuable for market.

Coutant is also a strong grower, and productive; fruit large, but crumbles and is unattractive in appearance.

Bradley:—A new variety received from C. P. Bradley, Indiana. Fruit medium to large, roundish, with an irregular surface; very firm. A trifle too dark red in color. Quality fair. Requires further trial.

GOOSEBERRIES.

There was an excellent crop of gooseberries, upon English varieties especially. Chautauqua, Keepsake, Columbus, and Triumph being the best kinds. Lancashire did fairly well, while Apex, Bendelon, Golden and Industry were less satisfactory. The season was very favorable for mildew, but frequent spraying with liver of sulphur kept them entirely free from the disease. Downing is still the best of the American kinds although Josselyn and Pearl did fairly well. Houghton and Pale Red are small, dull red and are not to be compared to the other kinds in value.

CURRANTS.

The currant crop was better than for two seasons. Red Dutch gave the heaviest yield of any variety; London, Holland, and Wilder coming next. Fay, Select and Cherry gave fair yields of very fine, large fruit, which brought the highest market price.

Red Dutch and Victoria are productive but the berries are too small, Versaillaise, Ruby Castle, and North Star are moderately productive varieties of medium-sized fruit. Pomona bears fruit of good size, but seems to lack hardiness as yet. London, Wilder and Cherry have been satisfactory and reliable. Wilder especially seems desirable; a late ripening, productive sort; berries large and of the Cherry type.

Comet and Red Cross.—The berries were of large size on both varieties but little can be said about them as yet, although planted in 1900. Red Cross is an upright, close, compact grower, resembling Fay in this respect.

Considerable injury is often done to the leaves of currants and gooseberries by leaf-blight and currant worms, but both can be readily controlled by one or two thorough sprayings with Bordeaux mixture and Paris green, or arsenite of lime.

GRAPES.

The grape crop was very good, Concord and Niagara producing the heaviest crop they have borne for some years. Of the one hundred ten varieties fruiting, not more than ten could be recommended for commercial purposes and most growers in Michigan would cut it down to one, and that variety, Concord. A large number of varieties are practically worthless, while others might do for some home collections, although we would not care to recommend them for general planting.

The crop was exceptionally free from disease, or the work of insects. Some plant lice made their appearance on the tender shoots late in the season, but did no apparent damage. Scarcely any mildew developed even upon varieties that are most subject to it. A small amount of anthracnose was noticed upon two or three varieties only. Black-rot did not make its appearance in the vineyard.

The dust spray was tested in comparison with a liquid spray of Bordeaux mixture and arsenite of lime for controlling mildew and anthracnose. Four applications of each were made, the first as the buds were ripening; the second, just before blossoming; the third, after the clusters and berries had well formed, and the fourth, ten days later. No mildew made its appearance on any of the varieties in the test. Rather more anthracnose made its appearance upon one variety (Guinevra), where sprayed with dust than with liquid, otherwise little difference could be seen. The dust spraying machine is rather unhandy in the vineyard, as compared with a spray pump, as it necessitates stopping and starting quite often in order to reach every portion, while with a spraying rod and

plenty of hose, the person operating a pump can work back and forth for a considerable distance so that liquid spraying is more satisfactory for spraying grapes. The remainder of the vineyard was given three applications of Bordeaux mixture, and one application of soda Bordeaux. The soda Bordeaux was applied early in August and is recommended for the rot of grapes and plums, as it can be applied when the fruit is beginning to ripen without staining the fruit. The usual formula is Babbitt's concentrated lye (soda), 1 pound; lime, 5 ounces; copper sulphate, 3 pounds; water, 30 gallons. In preparing this, two gallons of water were used to slake the lime, the same quantity of hot water for dissolving the concentrated lye and the copper sulphate. When cold, mix the lime and copper sulphate solutions and after adding the lye solution, dilute to 30 gallons with water. No very definite results were obtained as the vines were exceptionally free from diseases of any kind and held their foliage late in the autumn. The season was late and the grapes were considerably later in maturing than usual. The later-ripening kinds were not quite up to the standard in quality.

New Varieties.

Early Ohio:—Ripens with Moore's Early but is more productive than that variety. It lacks in quality, and the berries are small. Valuable only as an early variety.

Hicks and St. Louis are two new varieties received from Henry Wallis, Wellston, Mo., and both bore a good crop this season. Both ripen about midway between Moore's Early and Concord. Hicks has long, conical, compact bunches of medium size. Berries medium to large size, round, black, with blue bloom. Flavor, mild, vinous; quality fair. Of some promise as it fills in the season between the early and late purple grapes. St. Louis is less compact than Hicks; of the same size, color and growth of vine, but sweeter and better in quality. Ripens with the above variety, and should it prove as productive, would be preferable.

Green:—Bore a few small clusters this season, ripening a week in advance of Niagara, which it resembles, although more of a transparent yellow color. It is sweeter, but has the Niagara flavor.

Commercial Varieties.

The following list contains only well tested kinds:

Black:—Moores', Campbell, Early Ohio, Worden, and Concord. White:—Diamond, Guinevra, Niagara and Pocklington. Red:—Delaware and Vergennes. For the home collection, the red varieties, Brighton, Ulster, Iona, Jefferson and Diana could be added.

Brighton and Ulster are the earliest of this class and are of fine quality, Ulster being one of the sweetest varieties on trial. Jefferson and Diana are valuable as late keepers, and for that reason, are desirable for laying away in the cellar. The Jessica might also be added to this list. It is a small, productive, early-ripening white grape of good quality.

Catawba:—An old, well-known variety matured a partial crop of fruit this season, the first on fourteen-year old vines.

CHERRIES.

The crop of cherries was far from as heavy as last season, except upon a few varieties. All kinds bloomed full, but the fruit failed to set on a large number of varieties that are usually reliable. There were no injurious frosts, but the season was late and cold during the time of blooming and setting of the fruit, which may have had something to do with the difficulty. The dust spraying formula, No. 1, (lime, copper sulphate, lye, sulphur and Paris green), was used in a comparative test with liquid Bordeaux mixture and arsenite of lime for controlling leaf-blight and curculio. The work of the curculio in the cherry orchards has never been troublesome, as very little wormy fruit is found. There was no difference in the results with the two methods in controlling curculio. Very little brown rot made its appearance in the orchard and no difference in the amount was noted between the different methods. The dust was less effectual against other fungi than the liquid spray, although only three applications of liquid Bordeaux were given to five of the dust. One application of each was

given before the blossoms opened, and the rest after the blossoms had fallen, at intervals of a week, except that two applications of dust were made within one week after the blossoms had fallen.

The cherry-tree plant louse, a black, shiny aphis, which works on the young, tender growth and leaves, made its appearance in very large numbers and did much damage to the new growth and foliage. They work largely on the under-side of the leaves, but when in large numbers, they are found in the fruit spurs, causing both stem and fruit to curl, and secreting a sticky substance which injures the sale of the fruit. As they are sucking insects and have to be killed by a contact insecticide, it can readily be seen that unless the spraying is done before the leaves have curled over them, the results will not be very satisfactory. They have made their appearance in the orchard nearly every year, but not in sufficiently large numbers to do any serious injury until this year. Kerosene emulsion, or, better yet, tobacco water are the remedies recommended for this insect, as two bushels of tobacco stems soaked 24 hours in 50 gallons of water gave better results than kerosene emulsion using one pound of soap and one gallon of oil, to 10 gallons of water.

Notes on Varieties.

The varieties that gave the best results were, Morello, Montmorency, Dyehouse, Minnesota, Wragg, Northwest and Suda, the latter being a type of the English Morello; Hearts and Bigarreaus:—Napoleon, Kirtland Mary, Windsor, Ida, Ohio Beauty, Plymouth, and Wood; Dukes.—Montreuil, May Duke, Carnation, and Eugenie.

On the heavy laden trees the fruit was not quite as large as usual owing to the dry weather.

The above list of cherries will afford a succession and can be recommended for commercial planting.

PEACHES.

The crop of peaches was necessarily small this season, owing to the removal of a large portion of the older blocks. Longhurst, Gold Drop, Triumph, Brown, LaFleur, and Brunson came through the winter without injury and required thinning. Oceana, McCollister, California, Switzerland, and Bernice gave a fair yield. Waddell was the only variety to bear a full crop upon four-year old trees. Quite a number of the new varieties matured a few specimens of which descriptions will be given.

Spraying.

The early spraying of the peach trees for leaf-curl with copper sulphate, using two pounds to fifty gallons of water was attended with the usual good results, although the amount of injury from this disease upon unsprayed trees was comparatively small.

In the neighboring orchard, where spraying has not been practiced and where in some years the trees have been nearly defoliated by leaf-curl, we were given permission to carry on an experiment. The following formulas were used, viz.: Lime, sulphur and salt (25-15-8), Bordeaux mixture (4-5-50); and copper sulphate solution (2 pounds to 50 gallons of water).

One row across the orchard was used for each mixture and, except for other experiments, the remainder of the orchard was left unsprayed. The leaf-curl on the unsprayed trees was not as bad as in some previous years. Scarcely a diseased leaf showed on trees sprayed with the lime and sulphur wash and only a small number of diseased leaves showed on Gold Drop, Lewis and Switzerland in the rows sprayed with Bordeaux mixture and copper sulphate solution. There was much more leaf-curl upon the check row unsprayed, than on rows sprayed with either Bordeaux mixture or copper sulphate. The dust spray was also used for leaf-curl, but no results were noticed from the use of this spray whether applied in the fall or spring.

Fall Pruning of Peach Trees.

To further determine the effect, if any, from pruning peach trees in the fall, a number of four-year old trees were pruned early in December, 1903, and a

similar number of the same varieties were pruned in April. The trees were quite severely pruned, being well thinned out and headed-in one-half to two-thirds of the new growth. The only injury from the fall pruning noticed was, where the branches were headed back, and this was by an enlarged discolored area, extending back from one to three inches from the end. The results to date, would indicate that the practice of heading-in the peach tree in the fall or early winter, or at any time in the winter when the wood is frozen, if continued, would seriously injure the trees. No difference was noticed in number of fruits between the trees pruned in the fall and those pruned in the spring and there was no injury from thinning the branches. For the large orchardist with the question of help and other considerations at a very busy season of the year, this question must be answered by individual circumstances and conditions with the risk of injury, as noted, taken in consideration.

Owing to the small crop no experiments in thinning were carried on, but former tests have shown the value of this practice in increasing the size of the fruit, thus commanding a higher price for the fruit, also in saving the trees from breaking down and insuring a longer life and more regular crops.

New Varieties.

Admiral Dewey:—Matured a few nice specimens this year. Fruit medium to large; roundish to oblong, irregular; cavity broad and very deep; suture well-marked half way around; color yellow, nearly covered with light and dark red; flesh pale yellow, coarse, stringy, medium firm; flavor mild, vinous; quality fair. Shows some inclination to rot; ripens with Triumph (August 19), and resembles that variety. Should this variety prove hardy and productive, it will be a valuable acquisition, being the earliest yellow freestone.

Advance:—Bore a good crop of large, fine looking fruit that ripened August 15th. Being semi-cling and white-fleshed, its value is doubtful.

Banner:—Ripens with Smock but is much sweeter than that variety. Fruit medium-sized, roundish, oblong; color yellow with slight red blush; texture tender, juicy; flavor mild, almost sweet. Freestone. Ripens October 3rd. Valuable should it prove productive.

Carman:—First fruit this season. Fruit large, roundish, slightly compressed; color creamy white with a handsome red cheek; flesh white, tender, very juicy, with an aromatic flavor; quality very good. Freestone. Ripe September 5th. One of the best of the white varieties.

Clifton Park:—A white-fleshed freestone, ripening with Waddell. Of good size and handsomely colored but lacks the hardiness in bud and good quality of that variety. Ripe August 30th.

Delaware:—A white-fleshed freestone, of good quality, ripening in early September. Tender in bud for this section, lacks productiveness.

Emperor:—Ripens with Smock and seems practically identical with that variety. The trees are very strong growers, and tender in wood. Fruit large, roundish-oval; color yellow, with a slight red blush; texture tender and juicy; flavor sour; quality fair. Ripe October 6th.

Emma:—Ripens with McCollister and resembles that variety very much. Fruit large, roundish to roundish oval; apex large, prominent; color yellow with faint red blush; texture medium firm, juicy with a sprightly vinous flavor; slightly better in quality than McCollister this season. Requires further testing.

Eureka—Tree hardy in bud; fruit of good size, and handsomely colored, but is white-fleshed and a cling. It ripened August 30 and, at that season, it is not likely to be of any value for this section.

Frances:—Matured a few nice supecimens this season. Fruit medium to large, roundish-oval with a very prominent apex; color yellow with a pale red blush; flesh yellow, medium firm, juicy; flavor sprightly, pleasant. Freestone. Quality good. Ripe September 28. A promising variety owing to its season.

Hieley (Belle of Georgia):—Fruit medium to large; form oval, apex very prominent; color creamy-white with brilliant red cheek; flesh white, medium firm, and juicy, rather coarse; flavor mild, pleasant; quality good. Freestone. Ripe September 16th.

Hynes:—Fruit medium to large, round; color creamy-white, overlaid with dark rich red, handsome; flesh white, tender, very juicy; flavor mild, pleasant. Ripe August 30th. Semi-cling. Not valuable for this section.

Mathews Beauty:—Fruit large, irregular, roundish to oval, compressed; apex

prominent, slightly sunken; skin yellow, thick, tough; flesh rich yellow, tender, juicy, with mild, indistinct flavor; quality only fair. Ripe September 26th.

McIntosh:—Tree a strong grower, hardy in wood and bud. Fruit medium to large; form oval, compressed; skin, white with slight red blush; flesh white, tender, juicy, with a mild, pleasant flavor; quality good. Clingstone. Ripe September 17th. Of doubtful value for this section, being a white-fleshed clingstone.

Sea Eagle:—A late-ripening, white-fleshed peach, semi-cling, of very good quality; form roundish, slightly compressed; size medium to large; color white with a light red cheek, tender, and juicy. Not promising as it comes in the season of Salway, the best late-ripening, yellow peach in this section.

Victor:—Ripened on July 25th; said to be ten days earlier than Sneed, which is doubtful, as the average date of ripening for that variety has been July 19th. Fruit medium to large, and apparently hardy in bud, distinctly Elberta in form and color; creamy-white, striped and splashed with bright red; flesh white, very tender and juicy, with a vinous flavor. Quality fair. Cling-stone.

Wark:—Ripens with and is practically identical with Triumph. It is, however, a distinct variety as the glands on the leaves of Wark are reniform, while those of Triumph are globose. Tree, very hardy in wood and bud, and very productive. Fruit medium to, large, round; color yellow, completely overlaid with dark, dull red; flesh pale yellow, medium firm, stringy. Quality fair. Ripe August 18th. Semi-cling. Subject to rot. Not as desirable as Admiral Dewey, with which it ripens and which is a freestone.

Welch:—From the originator, C. B. Welch, Douglas, Mich. Tree, a strong grower and hardy in wood. Fruit medium to large, roundish-oval. Skin yellow with red cheek; flesh rich yellow, tender and juicy. Quality very good. Freestone. Ripe October 4th. Should this variety prove productive, it will be a valuable addition, for its season.

Worth:—Fruit medium to large, roundish oval; color, yellow with a handsome red blush; flesh rich yellow, medium firm and juicy. Freestone. Ripe September 28th. Gave the largest yield of any of the yellow freestones in the four-year-old block.

Older Commercial Varieties.

Of those that have been tested in the past, there were many that showed points of merit, but, coming in the same season with standard varieties and being no better, they cannot be recommended. The following kinds will give the best results.

Triumph:—Very hardy in bud; should be heavily pruned and thinned to get large fruit. Yellow-fleshed, semi-cling. Should be planted in a small way only, and is best for local markets. Subject to rot.

Lewis, Brown, Michigan, Bishop, Connett, and Waddell are all white-fleshed freestones following Triumph and ripening together. Lewis and Brown are practically identical. Lewis is the older variety and is very hardy in bud; when properly pruned and thinned, has given good results. Rots badly in some seasons. Bishop is not quite so hardy in bud, but is larger, smoother and more attractive and seldom shows rot. Connett and Waddell are both of the North China type, very hardy in bud, free from rot, but rather tender in texture for long shipping. Waddell is the better of the two, being very productive, high colored and fine in quality.

St. John:—A peach of very superior quality and appearance but rather tender in bud and does well only on the better locations. Only a fair shipper.

Champion:—A valuable large, handsomely colored, white-fleshed peach of fine quality; has given good results here, and is well spoken of by most growers who have tried it.

Barnard, Engle, Ford New and Oceana ripen at the same time. Engle and Ford New are the best of these varieties. Barnard is a little hardier in bud than the other varieties but lacks the size and fine appearance of the other kinds. Engle can especially be recommended for occupying a large space in the commercial orchard and Ford New is a variety that should not be lost sight of.

Elberta, Kalamazoo, New Prolific, Brunson, Longhurst, Gold Drop, McCollister, Lemon Free, Smock and Salway follow in close succession. Elberta is not as hardy in bud, nor as regular a bearer as some of the other kinds, but its large size, handsome appearance and good shipping qualities make it popular.

Kalamazoo, New Prolific and Brunson are equally desirable, being hardy in bud and valuable market sorts. Longhurst is of the Chili type and has been one of the surest bearers and one of the most satisfactory varieties on trial. Gold Drop is one of the most hardy in bud, but the glut that comes every year has made it unpopular with many growers. The fault, however, is not all with the peach, but in the slack cultural methods used. Heavy pruning and thinning of this and other varieties of the Chili type, would bring very different results from those now secured.

McCollister has also given excellent results. Ripens about with Gold Drop, is not so hardy in bud, but is of larger size and has a red cheek.

Smock and Salway have no equals in their season. Salway has given the better results of the two.

It is probable that the fruits of the new varieties will develop higher color as the trees get older and bear heavier. A large per cent of the new varieties are white-fleshed, which makes them of doubtful value owing to the opinion held by buyers concerning white peaches. Many white-fleshed varieties have given excellent results as to hardiness of bud, productiveness, quality and appearance, but have not been profitable.

PLUMS.

The yield was very good this season, considering the heavy crop last year. The trees did not set as full and there was much less thinning to do this season but, when the fruit matured, the trees showed a good crop.

The dust spray was again given a thorough test, using the two mixtures tried last year and two others.

Mixture No. 1:—One barrel of fresh lime, two and one-half pounds of common or crude potash, twenty-four pounds of sulphur, and four pounds of Paris green were mixed as follows: Two boxes two and one-half feet wide, five feet long, with 6-inch sides were made, and one-half barrel of fresh lime was put into each box, and the lumps were broken in pieces the size of a hen's egg. The lime in one box was dry-slaked by slowly sprinkling over it five gallons of water in which two and one-half pounds of crude potash had been dissolved. The lime in the other box was dry-slaked by sprinkling over it five gallons of water in which ten pounds of copper sulphate had been dissolved. After being allowed to cool the two lots were shoveled into one box and the sulphur and Paris green were added and the whole mass thoroughly mixed, after which it was sifted and was then ready for use.

For sifting, a box 15 inches square, with 5-inch sides and a double thickness of wire window netting nailed over the bottom, was used. Handles four feet long, were fastened to the sides of the box to avoid being right over the mixture, as it is very light and fluffy, and inhaling the dust of Paris green and other ingredients cannot fail to be injurious.

Mixture No. 2:—One barrel of lime was dry-slaked by slowly sprinkling over it 10 gallons of water in which 20 pounds of copper sulphate had been dissolved, first putting the lime in the boxes and breaking it into small pieces. The Paris green was added after the mixture was cool and it was then sifted.

Mixture No. 3:—Made by dissolving 6 pounds of copper sulphate in 4 gallons of boiling water, and slaking 6 pounds of stone lime with 4 gallons of hot water. After the lime had cooled, it was then mixed with the copper sulphate solution. The mass was then poured into a grain sack and the surplus water pressed out; 100 pounds of air-slaked lime were then thoroughly mixed with it, after which it was spread out and dried and two pounds of Paris green were added. The drying process was a difficult one and took considerable time. This mixture requires much more labor to prepare than any of the other kinds, as, in drying, it hardens into very small lumps that must be crushed to a powder.

Mixture No. 4:—Used for curculio, only. It consisted of one pound of Paris green to 50 pounds of air-slaked lime. Three applications were given; the first one just before the blossoms opened, the second when the fruit was set, and the third one, a week later.

No difference could be seen between the different preparations of dust sprays, nor between the dust sprays and liquid sprays, with seven applications of dust and only five of liquid, except in one case where three applications of

mixture No. 4 (air-slaked lime and Paris green), gave apparently as good results as seven applications of the other mixtures were used, except that the latter trees held their foliage better towards the end of the season and showed a smaller number of rotten fruits. In all of the tests, the trees were sprayed before blossoms opened and where the dust preparations were used, twice within a week after blossoms had fallen. All of the trees showed some wormy fruits but in no case was the crop seriously injured.

Liquid Bordeaux mixture (4-5-50) proved superior to any form of dust spray for holding the foliage upon the trees, while dust spray mixture No. 1, gave better results than the others.

Little difference could be seen in the amount of rot, between liquid and dust mixtures, except that mixture No. 4 seemed least effectual. Brown rot made its appearance in all of the plots late in the season but no serious harm was done.

For spraying late for brown rot, as the fruit began to ripen, soda Bordeaux was substituted in the place of a week copper sulphate solution as used in former years. It was used full strength (concentrated lye one pound, lime 5 ounces, copper sulphate 3 pounds, water 30 gallons) upon all kinds of fruit trees to note if it was injurious to the foliage. No injury was noticed on apple, pear, cherry, grape or European plum, but it burned holes in the leaves of the peach and Japan plum, for which it should be reduced to one-half the above strength and growers should be cautious in using it full strength upon anything except the grape. It is an excellent fungicide and valuable as a spray for fruits when ripening.

The dust sprays had very little effect upon the green aphis that works upon the young shoots of the apple and plum, which were numerous again this season. Tobacco water and kerosene emulsion were tried on a number of the trees with practically the same results as when spraying for the black aphis on cherry.

New Varieties.

Clyman:—One of the earliest of the European kinds to ripen. Of medium size, reddish purple and good quality. As yet only moderately productive.

Climax—A new plum of the Japanese type, orginated by Luther Burbank of California, and a very promising variety. Four-year-old trees matured a number of very large specimens. The fruit was bright red with yellow flesh and is of fine quality. An undesirable point was noted which, should it prove characteristic of this variety, would greatly lessen its value. It is a very firm-fleshed variety and many of the finest specimens cracked as they were ripening. Season with Abundance.

Muscat Free (prune):—This variety is very similar to Fellenberg, in both growth of tree and fruit, except that it ripens ten days later and is less sweet. Trees are slow, dwarfish growers, and lack productiveness as yet.

Splendor (prune):—Lacks productiveness as yet. Fruit long, tapering at both ends. Color dark purple with blue bloom. Flesh greenish yellow, moderately juicy, with a sweet, rich flavor.

Gold:—A native type, received in scion from Stark Brothers, in 1895, has borne a few specimens for two seasons. In habit, branches are slender, drooping; foliage and blossoms small. Fruit small to medium, round; yellow shaded with red on exposed side; flesh yellow, firm and juicy; sweet not rich; quality fair. Cling-stone. Ripe September 2nd. Often cracks open before ripe. Not promising in this section.

Chabot (Japanese):—Received in 1898. Tree an upright, thrifty grower; fruit medium to large; roundish, tapering to apex: yellow, shaded with red; flesh yellow, firm juicy, with a sweet, rich flavor. Ripe September 10. Cling.

Csaszar Syilva:—Received from Division of Pomology, U. S. Department of Agriculture. Fruit medium to large; dark purple; roundish ovate, compressed; flesh tender, juicy, greenish-yellow; flavor mild, vinous; quality fair. Ripe September 10th. Not productive as yet. Cling-stone.

Odell:—Received in 1896. Identical with Lombard as grown here.

Simpson:—Received in 1896 Matured a few specimens this season. Fruit small to medium; roundish-oblong; color, clear yellow; flesh yellow, tender, juicy; sweet, quality very good. Cling. Ripe August 30th.

The following older varieties have given best results for home and market purposes.

Japan Varieties.

Red June, Abundance, Burbank and Satsuma.

European Varieties.

Field, Bradshaw, Lombard, Fellenberg, Giant Prune, Shropshire, Damson, French Damson, Archduke, Black Diamond, Grand Duke, Bavay and Monarch. Other varieties which might be added are Lincoln, Murdy, Yellow Egg, Spaulding and Columbia. The above lists have been named about in the order of ripening and as it is larger than most growers like to plant, it can be cut down to any limit, according to the number of trees to be planted.

In marketing the large, fancy plums, the sixteen-quart crate rivals the four-basket crate, in popularity, the one-fifth bushel basket being used for medium or common stock. Early and late ripening kinds bring much the highest price. Aside from the Damsons, the small or medium-sized plums coming in mid-season, scarcely brought enough to pay expenses, and the planting of the larger kinds, giving high cultural methods, is to be recommended.

APPLES.

There was a heavy crop of apples in the northwest and northeast blocks, with only a fair crop from the southeast block. In the latter block, the trees were planted sixteen feet apart each way, and are now twelve and fourteen years old. With the exception of a few of the slower growing kinds, the trees had grown together so that the limbs interlaced and when laden with fruit, it was impossible to get through with the spray wagon or cultivator, and it became a question of cutting out every alternate row, leaving but one tree of each variety, or choosing a system of pruning which would practically hold the trees down in size. The latter method was chosen and instead of pruning this block in the early spring, as has usually been done, it was left until the middle of June, at which time the pruning was started, heading back the old wood the necessary amount to allow of getting through with a horse. The pruning was finished July 10th. Practically speaking, the object of the pruning at this time was to cut off the new growth that had been made and thus check the growth of the season.

By following this system every year, the trees can be held where they are. What effect this will have upon the trees can only be determined after a number of years. We hear of growers who are planting apple orchards with the trees 20 to 30 feet apart, with the idea of holding them in check so that they will not crowd, by severe pruning, and we will now have, on the Station grounds, an excellent demonstration of what this system will do. The trees are low headed and very symmetrical. Some trees have produced from one and a half to two barrels of first-class apples per tree although but one rod apart, and there is a great saving of labor in spraying and picking the fruit, as compared with very large, tall trees.

Spraying.

The apples were sprayed with Bordeaux mixture and arsenite of lime. The summer and early fall varieties received three applications, and most of the winter varieties were given four applications. The fruit was unusually free from scab fungus and worms, except upon some of the winter varieties that did not receive the last application where the increase in the injury from codling moth was quite noticeable. There was, however, a fine crop of apples harvested, although the market price was below that of last season.

The dust sprays were tested upon apples in comparison with liquid applications for controlling insects and fungi. The dust spray mixtures were the same as for plums, and alternate rows were sprayed with liquid Bordeaux and arsenite of lime, and the different mixtures of dust sprays. The same rows sprayed with dust sprays last year were sprayed with the dust sprays this season. Mixture No. 3 is a new preparation which was not used last year. The tests were also started in an apple orchard outside the Station grounds, but the amount of fruit set was so small that nothing definite was determined.

The results in the Station orchard were practically the same as last season.

Six applications of the dust mixtures were given and four of liquid. So far as the codling moth is concerned, the different dust sprays were about equally effectual, and compared well with liquid, but the test this year has again demonstrated that none of the dust sprays will control the scab fungus either on fruit or leaves. The injury from apple scab is fully as great as from worms and for this reason, the dust spray will not take the place of the regular Bordeaux mixture for apples, although it can be applied much quicker and with less labor. The preparation and application of the dust mixtures is, however, much more disagreeable than of the liquid.

Summer Spray for Scale Insects.

Upon the report from a California fruit grower that crude petroleum could be used as a spray, while the foliage was on, if followed within fifteen or twenty minutes with a solution of concentrated lye, it was thought best to try it upon a few apple trees that had been tested and were of no particular value. On June 7th, six trees were sprayed from one side with petroleum and this was followed immediately with one pound of concentrated lye to nine gallons of water upon two of the trees, and one pound of caustic soda to nine gallons of water for two others, and the remaining trees were sprayed with one pound of crude potash to nine gallons of water. The other sides of the same trees were then sprayed with the same solutions to note their effect without the petroleum.

The alkaline solutions were supposed to counteract the burning influence of the crude oil on the foliage and limbs, but this they failed to do and the foliage was killed wherever sprayed with the oil. The foliage was slightly burned on the sides of the trees where the alkaline solutions were used but not so seriously as to cause them to fall off. The oil, however, seriously injured the trees and killed the smaller branches.

Notes on Varieties.

A number of varieties ripened fruit for the first time this season, many of which promise to be valuable. The question of varieties is an interesting one to the grower and, with our present long list, the new varieties must develop some very desirable characteristics, to outclass those already well-known and largely planted. The demand is for varieties that come into bearing early, few caring to plant Northern Spy, Red Canada and Spitzenberg and others of their type, that are of the finest quality, but late in coming into bearing.

New Varieties.

Arkansas:—Received in scion from Stark Brothers in 1897. Fruit medium to large; roundish conic; yellow, shaded and colored with light and very dark red and sprinkled with small russet dots; flesh yellowish, very firm, fine-grained, breaking. Quality fair. Season January to May. A long-keeping red winter variety.

Benoni:—Planted in 1891. Fruit medium-sized; color yellow overlaid with bright red blush and dark red splashes. Form roundish to oblong, tapering to the eye; flesh yellowish, firm, with a mild, sub-acid flavor. Quality very good. Ripe August 31st.

Black Annette:—Received from B. Hathaway in 1894. Tree an upright spreading grower. Fruit medium, roundish, conic; greenish-yellow, overlaid, striped and splashed with dark red, and sprinkled with many large conspicuous russet dots. Flesh yellowish white, tender, fine-grained, rather dry, with a mild, pleasant flavor. Quality fair. Season December to April.

Boiken.—A very promising new winter variety. Matured a fair crop of fine fruit from trees planted in 1898. Trees moderately vigorous, spreading growers. Fruit large, oblate, conic; clear shining yellow, with a bright red blush; flesh white; firm, crisp, juicy, fine-grained; flavor rather brisk, sub-acid. Quality good. Season December to April.

Fameuse (Snow):—An old well-known variety of handsome appearance and of the finest quality. Matured nearly a full crop from twelve-year old trees. Inclined to scab badly, but when thoroughly sprayed is a valuable variety for home or market.

Gracie:—Received in 1890 from the late Peter Gideon of Minnesota. Trees strong, vigorous, spreading growers. Fruit large, roundish, oblate, ribbed; hand-

somely striped with two shades of red; flesh yellow, firm, juicy; rather sharp acid. Quality only fair. Season December to February. Badly affected with brown leathery spots under the skin. Should this prove characteristic of the variety, it would be of little value.

Honey:—Received in 1894 from Frank Ford, Ravenna, Ohio. Fruit oblate; greenish yellow; flesh white, medium-firm, rather coarse, not juicy. Flavor mild, sweet, pleasant. Quality good. Ripe September 20th. Not promising. Many more attractive looking apples.

Hyde King:—A very promising variety. The trees have made a strong vigorous growth, forming a handsome, round head. Fruit medium to large; roundish to oblate; color clear yellow, nearly covered with bright handsome red; very smooth. Basin broad, shallow, plaited; stem of medium length, stout, set in a broad, shallow cavity. Calyx, large, open. Flesh very firm, crisp, juicy, breaking, fine-grained; flavor sprightly, sub-acid; quality good. Season December to April. Should this variety prove productive, it will be a valuable addition to the long-keeping, winter varieties for market.

Keeschmemet:—Received in 1894 from Division of Pomology. Fruit large, distinctly oblate-conic, ribbed; color greenish-yellow, striped and splashed with dull red. Basin of medium size, plaited. Stem of medium length, slender, set in a large, russeted cavity; flesh greenish-white, tender, crisp, fine-grained, juicy; flavor mild, sub-acid. Quality good. Season December to March. Rather unattractive in appearance.

Kraus:—Received in 1895 from C. F. Kraus, Clarence, Erie Co., N. Y. Matured a few fine specimens this season. Fruit large, roundish, conic; color clear yellow, overlaid with bright red on one side; flesh white, medium firm, juicy, fine-grained; flavor, mild, pleasant. Quality good. Season November to January.

Lady:—Origin France. Matured a partial crop of small, handsomely colored fruit of fine quality. Desirable as a dessert sort for home use, and for market purposes for a strictly fancy trade, as it brings a very high price in the city markets. The trees are very upright, close growers and promise to be productive. The fruit is borne in thick clusters and is covered on one side with deep, rich red. Season December to March.

Limber Twig:—Trees spreading, drooping growers, forming a round head. Fruit small, roundish; color greenish-yellow, overlaid with dark, dull red; flesh greenish-white, very firm, moderately juicy, but of poor quality. Season January to May. Too poor in quality and unattractive in appearance to prove valuable.

Marshall:—Received from Stark Brothers in 1892 and said to be a California seedling. Fruit medium-sized, oval, tapering to the eye. Color, very dark red, almost black. Flesh white with red under skin, very firm, breaking, fine-grained, rather dry. Flavor sub-acid, pleasant. Season December to April. A promising winter variety if it proves productive.

Newby:—Received in 1894 from F. F. Newby, Carthage, Ind. Tree a rather slow, spreading grower. Fruit large; form variable, roundish to oblate, sometimes oblique; color yellow, overlaid, striped and splashed with bright red; basin large, broad, deep, plaited. Stem short, stout, set in a broad, deep, russeted cavity; flesh yellowish, with a sprightly sub-acid flavor. Quality very good. Season December to March. A promising new red winter variety.

Noble Sovari—Of Hungarian origin. Received from Division of Pomology in 1894. Fruit large, irregular, oblate-conic, ribbed. Basin medium-sized, rather abrupt, plaited. Stem very short, stout; cavity large, deep, russeted. Color yellow, overlaid and striped with bright red; flesh yellowish, medium firm, rather coarse, crisp, moderately juicy. Quality fair to good. Season November to February.

Paragon:—Received in 1890 from Wm. Parry, Parry, N. J. Seems identical with Mammoth Black Twig as grown here. Fruit medium to large, roundish-oblate; color yellow ground, overlaid with light and dark red; flesh, yellow, very firm, crisp, juicy, with sub-acid flavor. Quality good. Season January to May.

Palmer:—Received in scion in 1897 from the Division of Pomology. Fruit large, oblate, regular; color greenish-yellow, with faint tinge of red and russet dots and splashes. Stem very long, rather slender, set in a large, deep cavity; flesh yellowish, crisp, tender, juicy, fine-grained, with a brisk, sub-acid flavor. Quality good. Season December to February.

Palouse:—Received in 1895 from Geo. Ruedy, Colfax, Washington. Fruit large, oblate, regular; color yellow, striped and splashed with red. Basin narrow, deep,

abrupt. Stem short, stout, set in a broad, medium deep cavity. Flesh tender, crisp, juicy, fine-grained. Flavor mild, pleasant; quality very good. Season November to December.

Parlin:—Received in 1895 from Wm. Parry, Parry, N. J. Tree a rather slow, spreading grower. Fruit large, oblate, sometimes oblique; color yellow, striped and splashed with bright red; flesh white, tender, fine-grained, melting, not juicy; flavor, mild, rather insipid. Quality fair. Season October to December.

Poppleton:—Received in 1888 from O. Poppleton. Tree a strong, upright grower; fruit large, oblong; color greenish-yellow, striped and nearly covered with two shades of red; flesh greenish-white, tender, melting, fine-grained, moderately juicy, with a mild, half sweet flavor. Season November to December. Not a very promising variety owing to the time it takes to come into bearing.

Ralls (Genet):—Received from Division of Pomology in 1895. Fruit medium-sized, roundish-conic; color yellow, shaded and striped with red; flesh, yellowish, crisp, firm, juicy, with a sprightly, sub-acid flavor. Season December to March.

Sutton Beauty:—Received in 1892 from Ellwanger & Barry, Rochester, N. Y. Resembles Morris Red as grown here. The trees are vigorous, upright, close growers. Fruit medium-sized, roundish to oblate, conic. Basin, medium large, plaited, uneven; calyx, partially closed. Stem rather short and slender, in a medium-sized, greenish, russeted cavity; color rich yellow, overlaid and slightly striped with light to dark red and sprinkled with many yellow, russet dots. Flesh crisp, tender, juicy. Quality very good. Season November to March.

Wolf River:—Received from Stark Brothers in 1890. Matured a few nice specimens for the first this year. Trees are strong, vigorous, spreading growers. Fruit large to very large, oblate, conic; color yellow, overlaid with handsome red; flesh white, tough, leathery, moderately juicy, with mild, insipid flavor. Quality very poor. Season October and November. Considered a valuable market apple by some.

The following varieties have given at least two crops and seem to have some merit:

Bath:—A medium-sized, handsome, red apple, ripening the first week in August. At that season it would seem valuable as an early sort.

Bosnian—Received from the Division of Pomology in 1895. Ripens with and resembles Red Bietigheimer, but better in quality. The trees are strong, spreading growers, with large, broad leaves. Fruit very large, a number of specimens weighing sixteen and eighteen ounces; form oblate; color yellowish, nearly overspread with bright pink; flesh firm, crisp, moderately juicy, with a brisk, sub-acid flavor. Ripe last of August. Quite productive, but the fruits are so large that they are inclined to fall off before maturing.

Dudley:—This new variety ripens soon after Oldenburg and promises to be productive. Fruit large, yellow, blushed, striped and splashed with bright red; flesh crisp, tender, juicy; fine quality. Promising for both home and market.

Evans:—A large, handsome apple of very good quality. Season October to February. The trees are strong growers, but were rather late coming into bearing

Glowing Coal:—A promising market variety, ripening in early September. Fruit of large size, handsomely striped and of good quality.

Lady Sweet:—A very productive, sweet apple, of attractive appearance. Season October to January.

Magyar:—A handsome Hungarian variety of large size and a good keeper; but of only fair quality; with brown spots under the skin.

McMahon:—Of large size, yellowish-white, and of good quality, but very tender in texture. Productive, but requires careful handling in market.

Mother:—A very fine dessert apple, ripening in September. Size medium to large, oblong, conic; color yellow, overlaid and striped with rather dark, dull red; crisp, juicy; quality best.

Paw Paw:—A red winter apple of attractive appearance, of good quality, and a long-keeper. Rather slow in coming into bearing, otherwise a very good market variety.

Reynard:—A very large, yellow apple, ripening in September. Quality good. Productive.

Salome:—Producing heavier crops each year. Trees moderately vigorous, open, spreading growers. Fruit medium to large; roundish-conic and handsomely striped and splashed with two shades of red. Of good quality and a long keeper.

Springdale—A new variety of the Baldwin type. Bore a very heavy crop this

season. Fruit, medium-sized, smooth, regular. Color pale yellow, overlaid and splashed with dark red; flesh yellowish, very firm, juicy, fine-grained, with mild, pleasant flavor, not rich. Season January to April.

Summer Pegatch:—Large, handsomely striped and of good quality. Ripens the middle of September.

Sweet Orange:—This is an especially long-keeping sweet apple. Received in 1890 from the Division of Pomology. Matured a heavy crop of fine fruit. Trees vigorous, upright, spreading growers. The fruit is large, roundish, inclining to conic. Color dull yellow; flesh yellowish, very firm, moderately juicy, fine-grained. Flavor, sweet, not rich. Season January to May.

Yellow Bellflower:—An old variety, at one time largely planted, but is now seldom seen except in old orchards; very productive, of good quality, and a fairly good keeper, but inclined to scab badly.

The varieties below have shown themselves especially adapted for the home collection and commercial purposes:

Arnold:—A very desirable kind for home planting, and has given good results here for market. Trees very productive. Fruit, medium-sized, with a very attractive, yellow color, slightly blushed; quality very good. Season late fall or early winter.

Bailey (Sweet):—A large-sized, red, Autumn sweet apple. Very productive. Valuable for market.

Bough (Sweet):—A well-known sweet apple, ripening in August. Of large size and fairly productive; valuable for home planting and in a small way for market.

Buckingham:—Of some promise as a market sort. Trees moderately vigorous and productive. Fruit large, striped and splashed with red, making attractive looking fruit. Quality fair to good. Season November to February.

Chenango:—Ripens in late August; very productive; handsomely striped and tender, juicy, fine for eating. It is too tender for long shipping, but it is planted to some extent for market purposes.

Early Harvest:—A well-known, early-ripening, yellow apple of good quality, which was at one time a very popular family and early market variety, but has been replaced by other varieties.

Early Joe—A small, handsome, red apple, of best quality, ripening about the middle of August. Desirable for home use.

Fameuse Sucre (or Sweet Snow):—This fine apple should be in every collection. It is one of the best dessert fruits. Received in 1894 from F. H. Hoskins, Newport, Vt. Origin France. The trees are upright, open growers, only moderately productive as yet. Fruit medium size, roundish-oblate, regular; color dark, handsome red; flesh white with red streaks, crisp, tender, juicy, sweet, with the distinct Snow flavor. Ripens in October. Not subject to scab.

Fanny:—This variety seems to be productive and promises to occupy a place in the commercial orchard as an autumn variety. The trees are strong growers. Fruit, above medium; color yellow, overlaid, striped and splashed with two shades of red, making it very attractive in appearance. Quality best.

Gideon:—One of the hardiest and most productive varieties. Trees very strong, healthy; fruit medium to large, yellow with pink cheek, very smooth, quality fair. Desirable for market. Season middle of September.

Gravenstein:—Of large size, attractive appearance, good quality, productive, and a good variety for market. Season September.

Grimes:—One of the most satisfactory winter apples. The trees are productive and come into bearing early. Fruit of the highest quality and commands a high market price. Season November to March.

Hubbardston:—Of large size, good appearance, good quality and very productive. A standard winter variety.

Jefferis:—Small to medium in size, very productive. Ripens in late August, of the highest quality, and should be in every collection.

Jonathan:—Bears early, is very productive, handsomely colored and very high in quality. Brings the highest market price. Inclined to run small and requires the best of care to develop large size and good color in Michigan.

Lowell (Greasy Pippin):—A well-known variety. Large, yellow, fine eating. Ripens in September. Valuable for family use.

Mason Orange:—Of yellow Bellflower type but more highly colored, and of better quality; very productive. Season November to February.

McIntosh.—As a late fall and early winter variety, this has no superior. Trees

early and abundant bearers. Fruit of medium size, dark handsome color and fine quality. Brings the highest price.

Milwaukee:—A newer variety of some promise as a market sort, ripening in early September. Comes into bearing early; fruit large, striped, fair quality.

Minkler:—A long-keeping, red winter variety, that produces heavy crops in alternate years. Lacks quality.

Morris Red:—Received in 1890. Has borne several heavy crops of medium to large, red winter apples. Quality very good. Trees strong, upright, close growers. Season November to February.

Oakland:—Trees slow, spreading growers; very productive; fruit medium-sized; color yellow, overlaid with dark red; flesh has a mild half-sweet flavor. Season November to March. Of some value for market.

Oldenburg:—Hardy, vigorous, very productive. As a market variety, it has been more largely planted than any other in Western Michigan, during the past five seasons. Ripe August 15th. Too sour for eating, but excellent for culinary purposes.

Ontario:—Should be in every commercial orchard. An early and abundant bearer; fruit medium to large, attractive. Good quality. Would sell for Northern Spy. Season November to April.

Primate: Ripens in early August. Trees strong growers, but only fairly productive here. Very fine eating, valuable for home use only.

Red Canada:—Trees rather poor growers, and slow in coming into bearing, otherwise one of the very best long-keeping, red, winter, dessert varieties.

Red June:—Small to medium-sized, of a handsome red color, fine quality and very productive. Ripe August 15th. A valuable variety for home use.

Stark:—As a very long-keeper, this has few equals. The trees are strong growers, very productive, and the fruit is of fair quality. Season December to May. Valuable.

Titovka.—One of the hardy Russian kinds, ripening just after Oldenburg. Trees are poor growers but very productive. Fruit large, handsomely colored and sells well, although of poor quality.

Tolmon Sweet:—A well-known winter sweet; very productive .

Wagener:—A valuable variety to use as a filler between varieties that are longer coming into bearing. Inclined to overbear and, for this reason, the trees are often dwarfed and stunted. The fruit is attractive in appearance and good quality. Season October to February.

Wealthy:—Hardy, moderately vigorous, very productive, and of good quality and fine appearance. One of the most valuable market varieties on trial. Season September to October.

Yellow Transparent:—Valuable for both home and market. A very early ripening sort. Comes into bearing early and is very attractive.

CRAB APPLES.

The crop was rather light this year. Florence and Jelly bore full crops but they ripen too early and are too small to be profitable. Gibb and August are larger kinds but are of poor quality, and too early. North Star is a very productive early ripening kind, but gets mealy as soon as matured.

Dartmouth and Martha are especially promising sorts, as they are of good size, attractive appearance and very best quality. Virginia is a later ripening kind of some promise. Quaker is a large, late kind, yellow in color, with but litle red and of only fair quality.

PEARS.

The crop of pears was heavy from most of the older varieties. Fireblight made its appearance, but by promptly cutting it out, being sure to cut below the affected part, we were able to check the disease without loss or serious injury to the trees. The fruit was smooth and unusually free from worms or fungus, except on one tree of Flemish Beauty which was treated with Owen's Process. The fruit on this tree was so badly scabbed as to be almost worthless, although in former years, it was kept clean and smooth by three or four applications of Bordeaux mixture.

The pear psylla made its appearance in the orchard in large numbers but two

applications of kerosene emulsion completely checked them. It has done much harm in other orchards in the vicinity. It is a small, yellow, sucking insect and was noted here June 20th on the under sides of the leaves and on the branches at the base of the leaf-stems. If neglected, they will almost defoliate the tree, sucking the sap of the leaves, causing them to turn brown and fall off, prematurely stopping the growth of tree and fruit, which will be dark and sticky from the honey dew secreted by the insects.

The first application of emulsion consisted of one pound of soap, one gallon of oil and 14 gallons of water, with five ounces of pyrethrum powder; the second application given three weeks later, was made stronger, using one pound of soap, and one gallon of oil to 10 gallons of water with the same amount of insect powder. A slight burning of the edges of the leaves was noted upon a few of the trees, but the injury was not serious.

Spraying.

Most of the trees received three applications of Bordeaux mixture and arsenite of lime. The remainder of the trees were in a block of apples where the different mixtures of dust spray were used in comparison with liquid Bordeaux mixture. The only difference noticed between the dust and liquid sprays for pears, was that the dust mixtures failed to control pear leaf-blight and scab.

Commercial Varieties.

Giffard, Clapp, Favorite, Bartlett, Flemish, Souvenir, Howell, Angouleme, Seckel, Dana Hovey, and Kieffer have done best. Bosc, Anjou and Sheldon are slow in coming into bearing, the former variety proving the most productive up to date. Lawrence, Drouard and Winter Nelis are late-ripening kinds of some merit.

Summer Doyenne and Elizabeth are two valuable varieties for the home garden and in a small way for market, selling well in small packages for dessert purposes. Summer Doyenne is a small pear of good quality, and the earliest ripening on trial.

Giffard and Wilder ripen together but the latter lacks the productiveness and good quality of the former, although more attractive in appearance.

Clapp's Favorite ripens about a week later than Giffard, is of large size, fine appearance and very productive, but blights badly.

Flemish scabs badly but, when this is controlled, its large size, good quality and productiveness makes it a valuable market sort.

Souvenir is of the largest size, and is proving very productive. Resembles Bartlett in color and flavor but is larger and has a broad apex.

Howell is early and productive, but of only fair quality. Its smooth, clear yellow skin gives it a fine appearance.

Seckel and Dana Hovey are the finest in quality and bring the highest market price. They should be in every commercial orchard, and in gardens where pears can be grown.

Kieffer as a rule is quite free from blight and as it bears early and abundantly and comes at a season when it can be held for some time, it is very popular for market. It is quite inferior in quality, however.

New Varieties.

Conference:—Tree rather a slow grower; fruit medium to large; pyriform; color greenish-yellow, nearly covered with blotches of russet; flesh tinged with pink, tender, melting, very juicy; flavor sweet, rich. Quality very good. Season early October.

Drouard:—The trees are moderately vigorous growers and slow in coming into bearing. Fruit large, obovate, obtuse-pyriform; color, greenish-yellow, sprinkled with many russet dots; skin tough; flesh yellowish-white, rather coarse, granular, very juicy, melting, with a sweet, vinous, perfumed flavor. Quality good. Season December to February. The most promising winter pear on trial.

Florida Bartlett—Buds received from Star Bros. in 1900. Bark, foliage and fruit resembles Kieffer. Trees strong growing; fruit large, roundish-oval, tapering at both ends; color clear yellow, with dark brown dots; flesh greenish, firm, juicy, half-breaking granular; flavor, mild, almost sweet, perfumed. Quality fair. Season December and January.

Garber:—Bore a full crop this year. Of Kieffer type. Not so hard in core and much slower in coming into bearing. Colors up earlier than Kieffer but is less desirable than that variety.

Gray Doyenne:—Very slow in coming into bearing. Size, small to medium; form obovate, obtuse-pyriform; color yellow, russeted; flesh sweet, mild, aromatic. Quality very good. Season October and early November. Too late in coming into bearing.

Magnate:—Tree a slow grower, but an early bearer. Fruit of medium to large size, obtuse-pyriform; color greenish-yellow, melting; flavor, vinous, pleasant, almost sweet. Quality very good. Season early October. This variety and Conference are very promising new varieties.

Osband:—Very slow in coming into bearing. Tree a strong, upright, close grower. Fruit small, obovate, obtuse-pyriform; color greenish-yellow, with a bright red cheek, and sprinkled with small brown dots; flesh white, juicy, melting, with a sweet, pleasant flavor. Ripe August 17th.

Reliance:—Received in 1893 from P. J. Berckmans. Fruit medium-sized, roundish-oblate; stem long, slender; color greenish-yellow, russeted; flesh juicy, melting, with mild vinous flavor. Quality good. Ripe September 30th. Rather unattractive in appearance for a market variety.

QUINCES.

The quince trees were attacked by fire-blight to such an extent, that very severe cutting back was necessary and one variety, Meech, was removed. All of the varieties were affected and the pruning required to save the trees, cut the crop short considerably. The quinces were planted in a row of plums which had received liberal applications of stable manure which has induced a strong growth of wood and made the conditions favorable for blight.

Rea and Missouri are very large, fine quinces but the former is the more productive.

NUTS.

All of the nuts on trial fruited this season, except pecans and English walnuts.

Of the filberts and hazelnuts, Kentish Cob, an English filbert, matured a very fine crop of nuts. Cosford Thin Shell bore only a light crop this year, but gave a heavy yield last season. Both of these varieties produce good crops in alternate years and are especially recommended for the home garden and would no doubt prove valuable for commercial purposes. Our native hazelnuts are small, with thick shells and small meats. Not particularly desirable for planting, as they were much longer coming into bearing than the large English filberts in the same row.

The Japan walnuts continue to bear annually and grow vigorously. Desirable both for its fruit, which is fully equal to the butternut, and on account of the handsome appearance of the trees.

Chestnuts.

The Japan chestnuts, Numbo, Hale and Reliance continue to bear a few specimens, but seem of little value.

Of the larger European kinds, Paragon again proved the most productive. The yield was the heaviest it has ever been, and as a result, the nuts were smaller than usual.

The Comfort is fully as large as Paragon but has been much longer in coming into bearing. This variety is proving more productive each year and promises to be a valuable kind for planting.

Hathaway is a native type that has been slow coming into bearing. It bore a few specimens this season. The nuts were small, but are sweet and of good quality.

The pecan seedlings have made a vigorous growth and are handsome trees, but show little signs of fruiting as yet. The English walnuts freeze back every winter.

COVER CROPS.

The importance of cover crops in the orchard can hardly be over-estimated, especially in the peach orchards that are situated on light, sandy soils, and particularly upon elevations where the snow is likely to blow off during the winter months. The cover crops not only catch and hold the snow and foliage, but absorb moisture and soluble plant food, which might otherwise be washed away. The growing plants help to ripen up the new growth and buds, which is especially desirable in young, thrifty growing orchards. When turned under in the spring, they add appreciably to the supply of humus.

Special Bulletin Number 27 gives the observations up to the time winter set in, upon ten different plots of one-fourth acre each, that were planted in August, 1903, upon the Station grounds and on the premises of Mr. Frank Warner of Geneva township, who kindly consented to co-operate with us in testing different cover crops in his peach orchard. Mr. Warner chose a high, rolling, sandy portion of his orchard for the test.

The crops used were: Plot 1, barley one-half bushel; plot 2, barley one-fourth bushel and field peas, eight quarts; plot 3, barley one-fourth bushel, crimson clover two quarts; plot 4, oats one-half bushel; plot 5, oats one-fourth bushel, crimson clover, two quarts; plot 6, cow peas broadcast ten quarts; plot 7, cow peas drilled five quarts; plot 8, sand vetch eight quarts; plot 9, mammoth clover two quarts; plot 10, crimson clover two quarts.

Up to the time the snow came, Mr. Warner reported results practically the same as those on the Station grounds, that is, plots 1, 2, 3, 4 and 5, made an excellent growth and a fine covering for the ground. Plots 6 and 7 (cow peas) made a better growth at Mr. Warner's than at the Station, but the first frost cut them to the ground and he considered this crop practically worthless for the purpose.

In the 1903 report, it was said that there would be a good crop of clover to turn under the next spring; this, however, proved to be a mistake, except with the plot of mammoth clover, which came through the winter in fine shape, and gave a thick, heavy stand for plowing under. There was scarcely a live plant of crimson clover either at the station or at Mr. Warner's. At the latter place, the plots of sand vetch and mammoth clover were the only green crops to turn under. The barley, oats and field peas made a vigorous growth and held the leaves from blowing away. They formed a fairly good mulch and when plowed under would add materially to the humus in the soil. Barley makes a coarser and heavier growth than oats, and from two seasons' test, has proved superior to oats sown at the same rate per acre. The seed, however, is nearly double in price per bushel and it is a question as to whether it is enough more valuable for cover crop purposes to make up the difference in the price of the seed.

The long continued cold of last winter did much damage in orchards without cover crops, and the cover crops sown on the highest points and lightest soils in Mr. Warner's orchard failed to save all the trees from winter-killing, but he states that he believes the loss of trees would have been much greater had there been no cover crops in the orchard. On the Station grounds seven four-year old peach trees were winter-killed out of seventy-five, and these were frozen around the collar and in the trunk of the trees.

The roots were not brown or discolored. The foliage and blossoms came out on all of the winter-killed trees, showing that the circulation of the sap was cut off and the tops of the trees died from lack of nourishment.

The fact that the crimson clover was killed out, and that the mammoth clover came through the winter in fine condition is also worthy of note. The latter also makes a stronger growth of both top and root in the fall and is proving more satisfactory for cover crop purposes and for a green crop to turn under in the spring. Sowing oats or barley with the clover is better than clover alone, as the former makes a tall, rank growth and holds the snow and leaves better. The sand vetch is hardy and can be relied upon for cover crop purposes in an orchard but the seed is expensive, which will no doubt prohibit its use except in a small way.

When a green crop is not wanted for turning under, oats or barley will give very good satisfaction as a winter covering in the orchard.

A number of plots were again planted in August, 1904, and duplicate lots of seeds were taken by Mr. Warner and also by Mr. Geo. Chatfield, which will be reported the coming season.

REPORT OF THE UPPER PENINSULA SUB-STATION FOR THE YEAR 1904.

LEO. M. GEISMAR, SUPERINTENDENT.

[Special Bulletin No. 31.]

The principal work of the station during the season of 1904 was a continuation of the study of climatic conditions as related to crops which may be profitably adapted to this region. The work of planting, cultivating, spraying and harvesting is still largely done pioneer fashion. That results are effected thereby will seem obvious, but to what extent can be guessed much easier than ascertained. If it is admitted that the average pioneer farming is handicapped to a great extent, then the results of this and previous seasons may be considered inferior to what they will be when then can be obtained under the prevailing conditions of the average modern farm. On the other hand the plots which have been used have of necessity been too small for obtaining comparative results of sufficient accuracy. This limitation will be remedied to a great extent in the near future, the area under cultivation having been considerably extended and a portion thereof having been tile drained during the past season.

WEATHER CONDITIONS.

Date.	May.		June.		July.		August.		September.		October.	
	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.	Mean temperature.	Precipitation.
1	45	0	59	0	52.5	0	55	T	53.5	0.07	48.5	0.09
2	51	0	54	0	52	0	54.5	0	61.5	1.10	42.5	0.10
3	54.5	0	56	0.15	56	0.10	61	0	53	0.08	41	0.02
4	57	0	61	0.44	63.5	0.58	65.5	0.68	50.5	0	42.5	0.01
5	62	0	63	0.03	59.5	0	67.5	0	45.5	0	38.5	T
6	58	0.06	50.5	0.20	54.5	0	58.5	0.06	47.5	0.15	33	T
7	53	0.54	49	0.35	52.5	0	47.5	0	52.5	0.19	36	0.06
8	50	1.08	53.5	0	57.5	0.08	53	0	49.5	0.02	47.5	0.02
9	38.5	0.59	52.5	0	56.5	0	53	0.34	62.5	0.76	52	0.58
10	34.5	0.16	58.5	0	65	0	55.5	0.20	67.5	0	56.5	0.08
11	37.5	0.16	60.5	0	62.5	T	55	0	50.5	0.07	44	0.02
12	44	0	65	0	60.5	0.22	60.5	0.58	44	0	39.5	0.01
13	46.5	0.67	64.5	0.05	63.5	0	61.5	0.12	50	0.45	38.5	0
14	37	0.03	63.5	0.10	63.5	T	62.5	0	46.5	0.31	46.5	0
15	34.5	0.07	53.5	0	68	0	56.5	0.42	48.5	0.17	46	0
16	38.5	0	45.5	0	64.5	0	58.5	0	50.5	0	55.5	T
17	38.5	0.10	59.5	0.47	75.5	0	53.5	0	58	0.01	64	0
18	47	0.03	64	0.03	70	0.02	52	0	49.5	0	54.5	0
19	51	0	64	0	67	0	54.5	0	45.5	0.02	51.5	0
20	56	0	68.5	T	57.5	0	64.5	0	42	0	46	0.02
21	64.5	T	57	T	55	0.40	62.5	0.34	38	0	40	0.03
22	60.5	0.11	52.5	0	54.5	0.12	57	0	39.5	T	35.5	0.12
23	58	0.35	56.5	0	54	0	60	0	50.5	0.45	39.5	0.02
24	48	0	70.5	0	56.5	0	64.5	0	56.5	0.12	40.5	0.05
25	42	1.21	64	0.51	62.5	0	57.5	0.08	47	0.04	38.5	0.02
26	44.5	0.97	54	0	67.5	0.34	56.5	0	48	0.11	31.5	0.04
27	48	T	53.5	0	60.5	0	63.5	0.07	52.5	0	34.5	0.05
28	53	0	62	0	51.5	0	59	0	51	0.12	41	0
29	62	0.21	63	0.95	55.5	0	49	0	69	0.08	38	0
30	41.5	0	51	0.03	70.5	0.42	47.5	0.02	56.5	0	34.5	0
31	44	0	......	......	68.5	0	51.5	0.16	....	....	47.5	0
Total rainfall	......	6.34	......	3.31	....	2.28	....	3.07	....	4.32	....	1.29

T = Trace.
Mean = Maximum + Minimum ÷ 2.

For forage and root crops the season was extremely favorable and for cereals much better than any previous year since 1897, except 1902. There was a more normal rainfall, which, for the six months of the growing season, amounted to 20.61 inches, as against 18.29 for 1902 and 25.28 for both 1901 and 1903.

Temperatures ruled low throughout most of the season. The ground became partly bare April 23 and the last trace of snow disappeared five days later; but while planting began May 2, the ground remained cold until the middle of June. For the first time, there was practically a total absence of spring frosts, for, while the thermometer registered 30 degrees on May 31, no subsequent damage could be detected even upon the most tender vegetation. Light frosts occurred September 12, 20 and 21 and these were succeeded by a killing frost on September 22. October and November temperatures ruled high until permanent snow fell on November 25, the ground being unfrozen at the time. The greatest depth of snow during the preceding winter was 38 inches and was recorded on March 19.

The records of mean temperature and precipitation during the growing season are shown in the foregoing table:

FIELD CROPS—CEREALS.

The very favorable temperature conditions immediately following planting time, were largely offset by the continuous and heavy rainfall during May. As a consequence, the plants made a very slow growth and became an easy prey to the rust fungus, recuperating only during July. Owing to cool nights in August, the ripening season extended well into September, and the wet weather of the first half of September caused a second outbreak of rust. There was no damage either from grain aphis or other insects. The primitive methods of handling grain with cradle and hand flails are still in use at the station, making the amounts of grain lost by remaining in the straw through imperfect threshing, quite uncertain. This must be taken into account when looking over the actual and comparative yields of the plots. Realizing these facts, there has been neither time nor effort spared in taking the most careful and minute observations of the growth and behavior of all varieties from the time they are planted until they are harvested. The reader will therefore find the descriptive notes of some of the varieties of more importance than the tables of yields.

OATS.

Whether the damage from rust has heretofore been slight or severe, the oats have been invariably affected more than the other cereals. The Station is frequently asked for information concerning certain varieties of oats which are claimed to be rust proof, and the following may serve as a general answer. Several varieties claimed to be rust proof have been tested here, and all were damaged by rust fully as much, and in some cases more than certain other varieties for which no such claim is made Enough varieties have been tested here to warrant the statement that a so called rust proof oat owes its origin to the same "clever" propagating methods as a bug proof potato. The dryer the season, the less the spores of the rust fugus will be able to sprout. During wet seasons the early maturing varieties of oats will be damaged by rust much less than the late varieties; this however is not due to immunity, but merely to the shorter length of time during which the plants are exposed to the ravages from rust. Thus the earliest maturing variety, Early Champion, which is not claimed to be rust proof, was practically free from rust during the past season. Earliness therefore may well be considered a desirable quality whenever wet seasons are to be feared.

Among the promising varieties tested for the first time, may be noted: *Early Champion*, a white open head variety with small, but heavy grain and thin hull. Straw somewhat shorter than that of late varieties, but is of good size and texture. A very valuable sort, owing to its extreme earliness. *University No.* 6, a promising white variety of large size and heavy grain, the stiff straw enabling it to stand up well. *Swedish or Wisconsin No.* 4, a white variety with large, open heads and grain of good size. Will no doubt prove more valuable than the present yield indicates, for, owing to the poor quality of seed, the stand was thin. *White Shonen*, an open head, white variety as promising as the last two. Owing to the very small size of the plot, the seed was drilled in instead of broadcasted, and to this the better yield is no doubt partially due. *Improved Prize Cluster*,

a medium early white variety with good straw, but whose lower yield may possibly be due to the small, open heads. *Irish Victor*, a white variety with small heads but giving promise of better yields. The seed was poor and the stand but slightly better than the Swedish variety. *National, one* of the tallest white varieties with large, open heads. Further trials may show this to be a valuable sort; the lower yield being probably due to later planting, the seed having been delayed on the road. *Premium*, a white variety planted as late as the last and for similar reasons. Being a "side oats" however, its late ripening habit may prove to be an objectionable feature. *European Hulless*, a white variety with open heads and hulless as its name indicates. The seed was badly mixed, and what was true to name shelled out considerably. The variety ought to prove valuable as a poultry food. Further descriptions and results are shown in the following table:

Varieties.	Size of plots in rods.	Time of planting.	Headed out.	Time of harvesting.	Length of seed head inches.	Length of straw inches.	Yield of plots in lbs.		Yield per acre.	
							Grain.	Straw.	Grain bushels.	Straw lbs.
University No. 6....	1x8	May 2	July 15	Aug. 28	7½	48	68	114	42½	2,280
Improved Prise Cluster............	1x8	May 3	" 15	" 25	6	48	47	116	29⅜	2,320
Irish Victor.........	1x8	" 3	" 17	" 26	6½	46	60	127	37½	2,540
Swedish or Wisconsin No. 4.........	1x8	" 3	" 15	" 28	7¾	45	47	125	29⅜	2,500
Black Beauty........	1x8	" 3	" 21	Sept. 10	8¼	52	56	117	35	2,340
Duppauer...........	1x8	" 3	" 18	" 12	8	50	46	127	28¾	2,540
White Shonen.......	½x4	" 6	" 16	Aug. 26	7½	48	18½	53½	46¼	4,280
National...........	¾x8	" 14	" 22	Sept. 13	8½	52	39	108	32½	2,880
Early Champion.....	1x6	" 7	" 7	Aug. 16	7	44	57	126	47½	3,360
European Hulless....	1x6	" 11	" 16	" 26	7½	46	33	141	27½	3,760
American Banner....	1x4	" 12	" 17	Sept. 10	7¾	50	32	148	40	5,920
Premium...........	¾x8	" 14	" 27	" 18	10	52	30	105	25	2,800

BARLEY.

With very few exceptions the varieties of barley have given uniformly good results. In part this is due to the fact that barley is not attacked by rust to the same extent as oats or wheat, nor is it exposed as long to its milder attacks, being as a whole, a quicker ripening cereal. In part however this is due to the well known fact that, aside from the hulless varieties, barley shells out much less than oats or wheat, hence is better able to stand the frequent handling of the bundles which is rendered necessary by the present methods in use here. Varieties tested for the first time are: *Univrsity No.* 105, a six-rowed bearded variety with large, plump kernels and a fairly heavy straw. Whether as good or better than Manscheuri, could not be determined, the present difference being mainly due to poor seed of the new variety, while Manscheuri is grown from well selected seed raised at the Station. *French Chevalier*, an old and at one time leading two rowed variety with very long beards and large, well filled kernels. Breaks down more or less under the heavy heads and beards, though the straw is of good size and strength. Ripens too late for best results. It is doubtful whether any of the two rowed varieties can compete either with the six rowed or the beardless varieties. *Success*, a beardless variety. The seed as obtained was not only poor, but developed a very large amount of smut. Will no doubt give a better yield with proper seed selection, though the heads were uniformly short and the straw weak. *Champion*, a beardless variety and one of the best heretofore tested. The straw is heavy and of good strength for holding up the large well filled heads. *Chevalier*, another beardless variety, in every way identical with Champion, except as far as the price of the seed is concerned. By way of further comments, the reader is referred to Pages 10 and 14 of Special Bulletin No. 28 containing the anual report for 1903. The plot was located at the northern limits of the Station grounds, and the lower yield of this variety is due to damage by chickens.

The varieties as shown in the following table, were all planted on May 11, and all the plots were 1x8 rods in size:

Varieties.	Headed out.	Time of harvesting.	Height of straw inches.	Yield of plots.		Yield per acre.	
				Grain lbs.	Straw lbs.	Grain bushels.	Straw lbs.
Champion (Beardless)	July 5	Aug. 19	42	116	149	48⅓	2,980
Manscheuri 6 Rowed (Bearded)	" 9	" 19	34	111	149	46¼	2,980
University No. 105 (Bearded)	" 10	" 22	34	94	102	39⅙	2,040
Success (Beardless)	" 1	" 16	29	54	98	22½	1,960
French Chevalier (Bearded)	" 19	Sept. 16	31	48	133	20	2,660
White Hulless (Hulless)	" 4	Aug. 17	32	42	152	17½	3,040
Chevalier (Beardless)	" 1	" 16	42	86	107	35⅚	2,140

WHEAT.

Two winter wheat varieties were planted, Dawson on September 1 and International No. 6, on September 15. The stand of International was poor when permanent snow covered it on November 11. Dawson was much better, and about 85 per cent of a perfect stand. As soon as the snow had disappeared during spring, nearly 90 per cent of the plants on the International plot, and approximately 20 per cent of those on the Dawson plot, appeared lifeless, the dull green color soon turning brown and the plants drying up within two or three days. The International plot was subsequently fitted for field peas. No insects nor the work of any could be detected either upon the plants or upon the roots. No other cause can be assigned unless it be a lack of air which caused the weaker plants to suffocate. Several hard crusts formed on the snow during December and forepart of January owing to quite warm spells. From soon after the middle of January to the end of February there was steady cold weather with not enough snowfall to permit the thawing of the snow crusts before the beginning of March. Though these crusts had melted away under the snow long before the advent of spring, owing to the unfrozen condition of the soil, it is quite probable that they remained long enough to do the damage by intercepting a free circulation of air. Both Dawson and International had been tested in 1901, when they gave a yield of 41 and 33.23 bushels per acre respectively. The spring wheat varieties have been tested twice before, and the present yield may be considered very satisfactory when considering the very low average of the principal wheat growing states. The results are given in the following table:

Varieties.	Size of plots in rods.	Time of planting.	Headed out.	Time of harvesting.	Length of straw inches.	Yield of plots.		Yield per acre.	
						Grain lbs.	Straw lbs.	Grain bush.	Straw lbs.
Dawson (or Golden Chaff)	1x6	Sept. 1	June 21	Aug. 11	54	57	155	25⅓	4,080
Saskatchawan Fife (Spring)	1x8	May. 11	July 17	Sept. 10	50	62	190	20⅔	3,800
Velvet Chaff (Spring)	1x8	" 11	" 19	" 20	50	60	158	20	3,160
Minnesota No. 163 (Spring)	1x8	" 11	" 18	" 20	48	38	151	12⅔	3,020

OTHER FARM CROPS.

Speltz, or Emmer, as it is frequently called, is less subject to attacks from rust than most of the other cereals, and as such may be depended upon for good yields in this region. Its feeding value is nearly equal to that of barley, though best results would probably be obtained only by grinding the grain, as the husks are very hard and cannot be well removed except with special machinery. Its weight as threshed is generally taken at 24 lbs. per bushel. One plot 1x6 rods was planted May 6. The grain was cut September 2, having headed out July 13. The heads averaged 2½ inches in length, and the straw 42 inches. The yield was 63 lbs. of grain and 105 lbs. of straw, being equal to 70 bushels of grain and 2,800 lbs. of straw per acre.

Buckwheat. The season was very favorable for this crop and the grain ripened well.

Rye Buckwheat which gave the largest yield, appears to be a very prolific variety. The kernels are smaller and with edges nearly smooth. It is probably less desirable for milling purposes, but seems better adapted to poultry feed. The *Japanese* was raised from seed which ripened here during the preceding season and the seed from the Michigan Experiment Station appears to be the same variety. Owing to frequent handling, a considerable amount of grain was lost by shelling out, and judging from the appearance of the ground there was twice as much lost from the Rye Buckwheat variety as from the other two. The plots were ½x6 rods in size and the results were as follows:

Varieties.	Length of straw inches.	Time of planting.	Blossomed.	Time of harvesting.	Yield of plots.		Yield per acre.	
					Grain lbs.	Straw lbs.	Grain bushels.	Straw lbs.
Japanese	48	June 7	July 12	Sept. 12	24	72	26⅔	3,840
Michigan Experiment Station	48	" 8	" 14	" 12	27	72	30	3,840
Rye Buckwheat	40	" 9	" 21	" 12	33	45	36⅔	2,400

Lentils. A description of this valuable legume is given on page 14 of Special Bulletin No. 20. The variety tested during the past season is the *Bohemian Blue,* the grain being small to medium size, and the color very dark blue, marbled with grey. The ½x6 rod plot was planted May 11, and the plants started in blossom July 7. Much of the grain and foliage was lost by harvesting too late on September 16. The plot yielded 16½ lbs. of grain and 63 lbs. of straw, being equal to 880 lbs. of grain and 3,360 lbs. of straw per acre.

Flax. A small plot ½x2½ rods was planted May 12 with seed previously ripened here. The plot was shaded on the west side by the standing timber and on the south side by several rows of sunflowers. The plants were thus slow in ripening seed, blossoming July 13 and being harvested September 16. The yield of seed was 6½ lbs., or at the rate of 14 6-7 bushels per acre.

Hemp. Since 1901 when the plants made a very fine growth, an attempt has been made each year to grow a larger plot in order to determine the comparative yield of seed per acre, as well as the adaptability of the crop under the different conditions of temperature and moisture of several successive seasons. Seed obtained from several seed houses has invariably proved worthless, the least poor during the past season having produced 16 scrubby plants upon a plot 1x4 rods. Whether the seed sold by grocery stores for canary bird seed, and at less than half price, is very much poorer, has not been ascertained.

Field Peas. The varieties heretofore tested, continue to make the same rank growth of vines as during previous seasons. Three new varieties were tested with the hope of finding one which would grow vines of reasonable length. These were: *Victoria,* from seed kindly furnished by Judge L. C. Holden of Sault Ste. Marie. A very large, white pea of showy appearance and with stout vines which owing to their average length of 9½ feet were unable to hold up the large heavy pods. Vines with large and abundant foliage of medium dark green color. The stand was deficient, and scarcely 60 per cent of it perfect, a fact being due to much of the seed having been left uncovered at planting time. The same applies more or less to all other large seeds, the attempt to cover them successfully with a harrow having thus far been a failure. *Canadian Blue,* peas medium to large size and of a greenish dark blue color. Vines medium heavy with small but abundant dark green foliage, and averaging 9 feet in length. *French June.* The most desirable of any variety thus far tested. Peas of even, small size, globular and cream colored. Vines slender but upright, and sufficiently stout to hold up the pods. Foliage ample and of a light green color. The vines averaged 5 feet in length and ripened to the tips, thus rendering the curing an easy and rapid task. One of its good features is its early ripening habit. For sowing with oats, this variety is well adapted for planting with Early Champion. Observations taken August 5, showed that the two crops, if mixed, would have been ready

to cut; the lower pods of the peas being then nearly ripe, while the Champion oats were beginning to turn.

The loss due to reasons already mentioned, is invariably greater with peas each year, than with other grain crops, for even with frequent handling it is difficult to keep the bottom of stacks dry and more or less of the peas from sprouting. *Canadian Field Peas* received from Michigan Experiment Station were planted May 12 and blossomed July 17. None ripened, either for being planted late or for being a very late variety, or for having been planted upon spring plowed stubble. The vines continued to grow, many exceeding 12 feet in length and being still partly in blossom when plowed under late in October. The results of the varieties are shown in the following table:

Varieties.	Size of plots rods.	Time of planting.	Blossomed.	Time of harvesting.	Yield of plots.		Yield per acre.	
					Grain lbs.	Straw lbs.	Grain Bu.	Straw lbs.
French June	1x8	May 2	July 3	Aug. 22	90	122	30	2,440
Victoria	1x8	" 2	" 7	Sept. 15	51	70	17	1,400
Canada Beauty	1x8	" 2	" 11	" 15	69	124	23	2,480
Black Eyed Marrowfat	1x8	" 2	" 9	" 22	58	132	19⅓	2,640
Egyptian Mummy	1x8	" 2	" 8	" 22	75	92	25	1,840
Improved Prussian Blue	1x8	" 2	" 11	" 15	72	133	24	2,660
Scotch	1x8	" 3	" 13	" 15	78	133	26	2,660
Canadian Blue	1x6	" 7	" 10	" 15	60	99	26⅔	2,640

Corn. The weather conditions for corn were much the same as during the preceding season, the plants having made a very rapid and thrifty growth during July, but practically remaining at a standstill during August. A few varieties ripened what may be termed "soft corn," while several others, as during former years, arrived at a stage where they could have been used for ensilage. Some of the more advanced varieties would have probably ripened thoroughly had they been planted earlier, but the weather at the end of May being cold, planting was delayed while waiting for frosts which never came. It is not likely nor scarcely possible, that the practically total absence of spring frosts was due to the more extensive clearings which have been recently made, for the extent thereof is still insignificant when compared with the vastness of the surrounding timbered region. On the other hand, these clearings are going on at a much more rapid rate than the average elsewhere, and it will seem advisable hereafter to plant earlier even at the risk of replanting, for in general field work it would seem an act of wisdom to risk the cost of the seed rather than the value of the crop in a region where a matter of 10 or 12 days is of greatest importance. Moreover the general weather conditions and the "frost scare" of the past two seasons even in the "corn belt," at no time more than during the past season, suggested the necessity for experiments which may determine the influence of soil temperature upon certain crops. There is sufficient data on hand to warrant the conclusion that certain crops, especially those in process of being acclimated in northern latitudes, may be materially influenced by soil temperature as affected by simple methods of soil manipulation. It is hoped that the additional cleared area of the past season will permit the undertaking of such experiments during the coming season. None of the varieties were damaged by the light frost of September 12, but all were practically killed on September 22. Of the varieties most likely to succeed here, the following in the order named give greatest promise: *Will's Dakota* and *Gehu* which ripened "soft corn," *Golden Dent* from seed kindly furnished by the North Dakota Experiment Station, and *Early Adams*, from seed donated by S. M. Isbell of Jackson, Mich. Final observations were taken September 20, and the varieties and their condition at that time are shown in the following table; the varieties having all been planted June 10:

Varieties.	Tasseled.	Silked.	Height in feet.	Condition at close of season.
Early Minnesota	Aug. 16	Aug. 31	6	Kernels in milk.
Triumph	" 10	" 24	8	Kernels in milk.
Longfellow	" 10	" 25	7	Kernels in soft dough.
Early Squaw	" 6	" 23	4½	Kernels in soft dough.
Early Adams	" 10	" 21	6	Kernels in hard dough.
Mercer	" 20	Sept. 2	7½	About one half of the ears partly developed.
Early Adams or Burlington	" 9	Aug. 23	7	Kernels in soft dough.
Will's Dakota	" 5	" 15	5½	Most of the ears ripened soft corn.
Golden Dent	" 8	" 19	6	Hard dough with a few ears nearly ripe.
Gehu	" 5	" 15	5½	Most of the ears ripened soft corn.
Acme Fodder	" 9	" 21	7	Kernels in soft dough. Some ears well glazed.
Extra Early Adams	" 7	" 20	5	Kernels in soft dough. Some ears well glazed.
Golden Ideal	" 23	Sept. 4	8	Most of the ears only partly developed.
King Philip	" 21	" 2	8	About one half of the ears partly developed.
Smutnose	" 12	Aug. 24	8	Kernels ranging from soft to hard dough.
Northwestern	" 8	" 22	6½	Kernels ranging from soft to hard dough.
Dakota Golden	" 11	" 25	7	Kernels in soft dough.
Minnesota No. 13	" 11	" 24	7½	Kernels in soft dough.
Minnesota King	" 10	" 23	7	Kernels in soft dough.

FORAGE CROPS.

The weather conditions were favorable for all varieties until September. Thereafter the frequent rains made outdoor curing a difficult task, and for this reason second crops of some of the grasses were left unharvested. The varieties tested for the first time are: *Meadow Fescue*, though the plot is the smallest, the grass amply showed its superiority for yield and quality, the tall and abundant foliage remaining well preserved until cut. *Bromus erectus*, the stems and seed heads being more slender than those of Bromus inermis, the hay is correspondingly less coarse. The yield also will probably be less, though comparisons are unsafe until pure seed can be obtained, the present plot containing a large percentage of oat grass, Fox tail and Orchard grass, while the seed of bromus inermis as planted in 1901, was free from any mixture. *Meadow Fox Tail.* The earliest of all grasses tested, and will furnish pasture almost as soon as the snow disappears. More valuable for pasture than for meadow the foliage being short but abundant. *Kentucky Blue Grass*, better known as June Grass, one of the most valuable grasses, and in this region, as much despised as any noxious weed, owing to its ever readiness in preempting every available space, and its persistency in running out other grasses. Owing to the poor stand of sanfoin the plot was plowed up, several attempts at reseeding having been unsuccessful owing to the poor quality of the seed.

Two legumes tested for the first time, ought to prove very valuable for late pasturing, their hardiness being unsurpassed by anything ever tested here. One is *Seradella*, planted May 21. The slender stems and numerous small leaves remained inconspicuous until after the small pink and white blossoms appeared July 19. Thereafter the rows which were 18 inches apart were soon covered with a thick mat of vines which averaged over 3 feet in length and were still growing and blossoming at the beginning of November, showing scarcely any damage from any of the preceding frosts. The other legume is the *Chick Pea* (cicer arietinum), planted May 21 and beginning to blossom July 14. The stout, erect and many branched plants reached a height of 2½ feet and set numerous pods about one-half of which contained peas, though for some unaccountable reason, very few ripened. The plants at the beginning of November were but slightly more damaged from frosts than the Seradella plants. The seed was bought for Idaho Coffee Peas, it being said of it that it does "not at all resemble the German Coffee Berry" and that it is a native of Idaho. The so-called German Coffee Berry is a fraud. The chick pea is a native of Europe, not of Idaho.

The greatest portion of the terraces south of the creek is too wet for most crops, and the lower terrace naturally more so than the rest, having been overgrown with sedges, cat tails and other aquatic plants. By hauling sand at spare times during several seasons and filling the lowest places it became possible to plow about one-half, or about 1¼ acres of the lower terrace. The plot, as shown in the following table, was seeded down for a permanent meadow, in July, 1903, 12 lbs. of alsike clover and six lbs. of timothy seed per acre being used. The dryer

season and the fact that a nurse crop was used in the shape of one bushel of oats per acre, made it possible to secure a perfect stand, and the oats were left as a mulch. Bromus inermis continues to give a good record, considering the poor condition of the plot. Upon the lower portion the grass holds its own, though the wet condition of the plot is indicated by cat tails creeping in. On the dry portion of the plot the grass averaged 6½ feet high when cut. The terraces south of the creek are under way of being tile drained. When finished, it will be possible to test all varieties of grasses under uniform conditions.

Varieties of *Lupines* tested for the first time, made a luxuriant growth and displayed a hardiness almost equal to Seradella, continuing to blossom until plowed under in November. *White Lupine.* The very stout plants blossomed August 11, producing numerous pods 3 to 3½ inches long, none of which ripened seed. Blossoms very large and ornamental, keel dark blue, with wings light blue tipped, and standard nearly white. The very stout tap roots penetrated to a depth of 10 to 15 inches, many being provided with large nitrogen gathering tubercles. The plants averaged 42 inches in height. *Blue Lupine.* Foliage darker green than the last. The blossoms which appeared August 20 are equally large and ornamental; base of standard golden yellow, fringed with white, balance and wings as well as keel a deep sky blue. In other respects the same as the last, the plants averaging 45 inches in height. *Mixed Lupines* proved to be a blue lupine of a different and more slender growing variety, but fully as ornamental. Blossomed August 25 and reached a height of 38 inches. The varieties were not planted until June 20, and may possibly ripen seed if planted earlier.

Australian Salt Bush and several varieties of *Lathyrus* proved to be as hardy as the lupines, but were planted too late to give any definite results. Of three varieties of cow-peas, *Michigan Favorite, New Era* and *Black Eye* none advanced far enough to blossom. Soy beans are more promising of ultimate results. The *Ogemaw* made the best growth during the season. Planted June 7, they blossomed August 7, setting numerous pods with beans in various stages of development, though none ripened perfectly. The plants made a rank growth, averaging 38 inches in height. Two varieties of Sorghum, *Amber cane* and *Albaugh Early* planted June 8, were not fully headed out at the close of the season. Three varieties of Broad Beans were planted June 16. *Large German or Antwerp*, blossomed July 20, and with earlier planting will no doubt ripen here. Except for being somewhat soft, most of the beans ripened during this trial. The plants are very stout and well able to stand up under the heavy load of pods which are 4 to 5 inches long. No injury was visible from light frosts, nor were all plants destroyed by killing frosts of late September, many continuing to blossom until the end of October, and when plowed under November 7 were found to have made a new growth of 3 to 4 inches close to the ground. The roots were found supplied with very large nodules, though none have even been found upon the roots of any other variety of beans either during this or any preceding season. The plants reached an average height of 42 inches. *Broad Windsor* blossomed July 20. The plants like the last are usually single stemmed, erect and very stout. Except for being smaller, the variety which averaged 38 inches high, resembles the last and is equally promising. *Japanese Small Soramame* resembles the last two except for being more dwarf and somewhat later. Blossomed August 3 and averaged 28 inches in height. Among the millets tested, *Siberian* is one of the hardiest and best yielding varieties for hay. *Early Fortune*, a common fox tail variety has some merits for hay, but proved inferior to Hungarian in this first test. *Tambof* is a dark colored broom corn millet giving promise of better results, the variety being hardy and early maturing. Owing to poor seed the stand was thin and the plants short. *Hog or Broom Corn* millet gives best promise for ripening seed, though it did not ripen perfectly during the past season. The plants averaged 5½ feet high and are too coarse for hay, but would be well adapted for siloing. *German Edible* is a variety, the seed of which is said to be used as food when crushed and cooked with milk. As tested, the variety proved to be a fox tail millet which could not be distinguished from the common German millet, and the seed did not ripen, though planted June 6. Unsuccessful attempts have been made at securing some seed of an edible millet which some years ago was introduced in the northern part of the Upper Peninsula by Russian immigrants. The variety, as seen at that time, was a broom corn millet, the seed of which was of large size and ripened very early, the Russians claiming it to be superior to oat meal for cooking purpose. Plants of the *Sand or Hairy Vetch* are occasionally found as

weeds. Anticipating that more might be found in the neighborhood of the plot which ripened seed during 1903, a small plot was planted early in May and alongside of wire netting which gave the plants an opportunity for climbing at will and a better chance for ripening seed. A few plants appeared among field peas and Sand Lucerne which had been planted upon and adjoining the plot which had ripened the sand vetch the year before. These plants, at the time the two plots were harvested, had set numerous pods, but even in the most advanced, the seed was less than half developed. The plants which were allowed to climb were not seriously damaged by fall frosts. They were still partly in blossom at the beginning of November and had reached a height of 12 feet, but the seed in the most advanced pods was not more than half developed. This and former tests would seem to show that the plants will not ripen seed unless planted during early fall, hence the danger of becoming a weed in this region is very remote, while as a weed destroyer, the plants are more effective than any other except field peas, judging at least from observations made during the past two seasons while trying to discover the most economical method for destroying Canada thistles and quack grass.

The yield of the *Alfalfa* plots has increased each year, and the large yield of the past season shows that the plants are now fully established and that this valuable crop is well adapted to Upper Peninsula conditions. The success obtained at this Station and the agitation of the public press have awakened a deep and increasing interest in this crop in nearly every part of the Upper Peninsula. Numerous letters of inquiry have been received during the past two years, and the number is increasing recently owing to a misconstruction placed by certain newspaper writers upon the proper value of "the fertilizer which is distributed free in the shape of yeast cakes." Many, in fact most, of these letters come from parts of the Upper Peninsula where alfalfa may or may not succeed. They show that failures have not been rare, and that alfalfa refused to grow upon rich soil in spite of inoculation with artificial cultures and with soil which had been imported at a great expense. A short discussion at this time may therefore prove to be worth many times more than the cost of maintaining the Station. In the limestone region of the southern and eastern slope of the Upper Peninsula, quite a number of people, upon the Station's advice, have planted alfalfa within the past three years. No failure has been reported except in one instance, when contrary to advice given, alfalfa had been planted with rye as a nurse crop. The other failures have invariably been reported from the northern slope, and while several demands for a personal investigation had to be refused, it became accidentally possible to personally investigate two such failures during the past season. In both cases the land was producing heavy crops of common clover, but was underlaid with a hardpan at a depth varying from about 6 inches to 3 feet. The deeper the hardpan was found the more alfalfa plants were still growing. Such hardpan is likely to be found in the neighborhood and for quite a number of miles distant from the iron ranges. Apparently it is largely composed of swamp iron, is usually brittle and often no more than an inch in thickness. Wherever this hardpan is close enough to the surface to be broken up with a plow or subsoil plow, the land may possibly be well adapted to alfalfa, and trials on a limited scale are highly advisable. Other failures may be due to the acid condition of the soil. The litmus paper test is a simple operation, and it is always advisable to apply the test when deciding to plant alfalfa. A slightly alkaline reaction is preferable and where it shows merely neutral, it will pay to give an application of lime before planting. Nurse crops are to be condemned rather than encouraged. They may do for grasses or common clovers, but it is poor practice to attempt to "smother in kindness" plants which even without a nurse crop, require two to three years before they are fully established. The claim that young alfalfa plants need shading, is not intelligently fulfilled by means of nurse crops, for it means robbing as well as shading. That the plants are not killed in every instance, is no argument in support of the practice, but rather speaks for the vitality of the remaining plants which have been able to survive the ordeal. Without nurse crops, with good seed and with soil conditions as favorable, alfalfa, elsewhere as well as here, will yield a ton or more per acre during the first season when planted early in spring. One crop at a time ought to be enough. Soil fertility should need but little discussion in a region where nearly 95 per cent of the total area is still virgin soil, and where the remaining 5 per cent have probably been

overcropped in rare instances only. A porus soil is essential, and where a good percentage of vegetable matter is lacking, it can be readily supplied by plowing under clover, field peas or sand vetches early enough during the preceding fall to permit perfect decomposition for early spring planting.

When all conditions are favorable, the alfalfa plants, during the first and sometimes second season, may nevertheless behave as they have at the Station, i. e. assume a sickly appearance as if in need of moisture, and the leaves during midsummer turning more or less yellow and dropping off after a few days of hot, dry weather. Careful observations during several years would seem to point to the conclusion that this condition is due to a lack of moisture, and becomes manifest even during seasons which are too wet for most all other crops. Many plants are known to evaporate during the growing season a weight of water equal to several hundred times their own weight. This should particularly apply to alfalfa, since if cut at the proper time for hay, it will furnish a daily growth of nearly one inch during the entire growing season, the growth of the best plot during the past season having been 50 inches for the first cutting, 36 inches for the second and 25 inches for the third, or 111 inches during the season. The extreme longevity of alfalfa and its readiness to furnish several crops each season, indicate that the plants cannot be damaged by frequent cutting unless when perhaps done too late in the season. Frequent cutting reduces evaporation surface, hence is the proper remedy against the yellowing of the leaves, though in irrigated districts the trouble may be avoided by timely applications of water and is probably for this reason, practically unknown in such districts. As for tubercles upon alfalfa roots. It is no doubt true that they are necessary for best results, but it is equally true that satisfactory results have been obtained here without any tubercles, for during the past four years 2 to 8 plants have been dug up each season and no tubercles have as yet been found upon any roots, not even upon the plot of Turkestan alfalfa which was partly inoculated in 1903 with soil obtained from the Michigan Experiment Station. Equally negative results were obtained with two plots planted in the orchard at the same time and with the same seed, these plots being plowed up in 1902 as reported in a former Bulletin and owing to a poor job of plowing, quite a number of plants survived, and some were still found growing late in 1903. Each of these plants when dug up, was found with tubercles upon its roots. Similar results have since been obtained with a plot of sand Lucerne which was plowed up when found to be alfalfa. In shape, the tubercles resembled those found upon the roots of the Sand Vetch, and while some could probably be found upon the roots of some plants on the original plots, if enough were dug up, the prompt action of the bacteria upon all plants disturbed by plowing is nevertheless strange.

The depth of soil to permanent water will need but secondary consideration except in a few localities where, as at the Station, the soil of terraces bordering the streams may possibly be too shallow. The soil of the alfalfa plots has a depth of 12 to 15 feet to permanent water, and comparative tests will be started upon the shallow soils which average three feet in depth.

The difference in yield of the several plots is not a question of origin of the seed. It is due in the first place to a difference in the quality of the soil as explained in a former Bulletin, and in the second place to a difference in the vitality of the seed which resulted in a correspondingly good or poor stand. The same amount of seed, or at the rate of 30 lbs. per acre, was used for each plot, but as the seed was not tested before planting, the resulting stand ranges from the best, or about 90 per cent of a perfect stand for the German alfalfa, to the poorest, or about 65 per cent for the Turkestan. It follows that 35 lbs. of seed per acre is not any too much for the purpose of obtaining a perfect stand.

The yields of the plots are shown in the following table:

Varieties.	Size of Plots in Rods.	Time of Planting.	Time of Cutting.	Yield per Cutting in lbs.	Total Yield of Plots in lbs.	Yield per acre in lbs.
American Alfalfa	1x6	May 1901	July 5	198	....	
American Alfalfa	....	May 1901	August 12	101		
American Alfalfa	....	May 1901	September 10	91	390	10,400
German Alfalfa	1x6	May 1901	July 5	222		
German Alfalfa	1x6	May 1901	August 12	108		
German Alfalfa	....	May 1901	Sept. 10	93	423	11,280
French Alfalfa	1x6	May 1901	July 5	173		
French Alfalfa	....	May 1901	August 12	69		
French Alfalfa	....	May 1901	Sept. 10	62	304	8,106⅔
Turkestan Alfalfa	1x6	May 1901	July 5	182		
Turkestan Alfalfa	....	May 1901	August 12	59		
Turkestan Alfalfa	....	May 1901	Sept. 10	61	302	8,053⅓
Sand Lucerne	1x6	May 1904	August 26	60	60	1,600
Sanfoin or Esparcette	1x6	May 1902	June 28	33	33	880
June Clover	1x6	May 1902	June 29	117		
June Clover	....	May 1902	August 30	76	193	5,146⅔
Silesian Clover	1x6	May 1902	June 30	127		
Silesian Clover	....	May 1902	August 30	80	207	5,520
Alsike Clover	1x6	May 1902	July 2	199		
Alsike Clover	....	May 1902	Sept. 2	56	255	6,800
Tall Meadow Oat Grass	1x6	May 1903	June 30	156		
Tall Meadow Oat Grass	....	May 1903	August 29	57	213	5,680
Orchard Grass	1x6	May 1902	June 29	78	78	2,080
Meadow Fox Tail	1x6	May 1903	June 28	109	109	2,906⅔
Kentucky Blue Grass	1x6	May 1903	June 30	123	123	3,280
Meadow Fescue	½x6	May 1903	July 2	126	126	6,720
Bromus Erectus	1x6	May 1903	July 2	139	139	3,706⅔
Slender Wheat Grass	1x6	May 1903	July 25	204	204	5,440
Timothy	1x6	May 1902	July 16	130	130	3,466⅔
Red Top	1x6	May 1902	July 15	131	131	3,493⅓
Mixed Grasses	1¼ acres	July 1903	July 11	4,958	4,958	3,966⅔
Bromus Inermis	4989 sq. ft.	May 1901	July 15	488	488	4,295
Siberian Millet	¾x6	June 6, 1904	Sept. 5	180	180	6,400
Tambof Millet	1x4	June 11, 1904	Sept. 14	99	99	3,960
Early Fortune Millet	1x4	June 8, 1904	Sept. 14	120	120	4,800
Hungarian Millet	1x4	June 8, 1904	Sept. 14	152	152	6,080

POTATOES AND ROOT CROPS.

The season was quite favorable for potatoes until September, when late blight favored by wet weather checked the growth of the tubers. The damage from the disease was confined to the tops and to a percentage of small potatoes larger than usual. Owing to the frequency of the rains, spraying would have been impracticable and was not attempted. The vines were sprayed earlier in the season against early blight, and up to the end of August remained in a healthy condition. After using Paris green against potato bugs for several seasons, getting the poison from different sources, and using it at different strengths in water and Bordeaux mixture, it seems quite certain that this material cannot be relied upon when using the standard formula of one pound in 100 gallons of water. Careful observations during the past season, showed that Paris green used at this strength and obtained from three different places killed less than ten per cent of the young larvae, about one-quarter full grown and none of the full grown larvae, nor any of the beetles. By gradually increasing the dose, much better, though by no means satisfactory, results were obtained by using 1½ lbs. for 100 gallons and adding an extra pound of lime. Further observations will be taken next season when the dose will be increased to 2 lbs., or more if necessary. There is no reason why Paris green should not be subject to the same regulations as commercial fertilizers, for its effectiveness depends upon its composition equally as much. Scab accounts largely for the low yield of the six varieties planted June 13 and heading the list in the following table. Though the seed had been treated with corrosive sublimate, the treatment was rendered ineffective owing

to a mistake in planting the varieties upon plots which had been in potatoes during the two previous seasons when the seed had not been treated. To a smaller extent this is true of the seven following varieties planted June 10, though the plots having been in potatoes only during the preceding season, the damage from scab was not nearly as great. On the other hand a number of these varieties have been tested three or four years, and even under the most favorable conditions, have failed to give such a record as would commend them as profitable varieties. For market varieties, those of the Carman type continue to give the best yield, and of these Sir Walter Raleigh invariably gives the largest percentage of merchantable potatoes. *Dolsen*, from seed kindly furnished by N. Dolsen is a very promising variety of the Carman type. The skin is nearly pure white, with few and very shallow eyes. The tubers were very uniform in size, and the variety with further selection will prove very valuable. The potatoes are claimed to be very long keepers and were not sprouted when planted. Of the *Admiral Dewey* ripened during the previous season, the white specimens were selected for further propagation. The resulting crop was still slightly mixed, but with further selection the variety may prove to be valuable. The yield of the varieties is shown in the following table:

Varieties.	Size of plots in rods.	Time of planting.	Blossomed.	Yield of plots in bu.			Yield per acre in bushels.
				Large.	Small.	Total.	
Northern Beauty	1x4	June 13	Aug. 1	2	¾	2¾	110
Pingree	1x4	" 13	July 28	1½	¾	2¼	90
Pride of Michigan	1x6	" 13	" 31	3	1¼	4¼	113⅓
Honeoye Rose	1x4	" 13	" 29	2½	[illegible]	3 1-12	123⅓
Up to date	1x8	" 13	" 31	2¼	1	3¼	65
Pinkeye	1x6	" 13	Aug. 3	4½	1¼	5¾	153⅓
Wonder of the World	1x6	" 10	July 28	4½	1½	6	160
Wonderful	1x4	" 10	Aug. 1	1¼	1¼	2½	100
Harrington Peer	1x4	" 10	July 27	4	¾	4¾	190
Hurst	1x6	" 10	" 29	4½	1	5½	146⅔
Norther	1x5	" 10	" 27	2	1⅓	3⅓	106⅔
Rosy Morn	1x4	" 10	" 29	1½	¾	2¼	90
Dew Drop	1x4	" 10	" 28	2½	¾	3¼	130
Sir Walter Raleigh	1x6	" 6	" 24	9¼	¾	10	266⅔
Rose of Erin	1x6	" 8	" 20	7½	1½	9	240
Carman No. 3	1x6	" 9	" 23	9¾	¾	10½	280
Admiral Dewey	½x4	" 9	" 23	2	½	2½	200
Six Weeks	½x4	" 9	" 30	1¼	¼	1½	120
Northlight	1x5	" 9	" 24	5¾	1½	7¼	264
Dolsen	1x4	" 8	" 25	7	¼	7¼	290
Million Dollar	1x8	" 8	" 28	10½	1½	12	240

CONTINUATION OF POTATO EXPERIMENTS.

The experiments were the same as those made during the previous two seasons, except that no cut seed was used. A one-half acre plot was used, the plot being 5 rods wide and 16 rods long, one-half of the plot, or 5x8 rods, being planted November 6, 1903, and the balance in the following spring. Owing to wet weather at the beginning of June, spring planting was delayed until June 6 and was finished June 8. Three rows of each of the four varieties shown in the following table were planted for hilling up, and three rows for level cultivation, the plot being thus divided into 24 rows 16 rods long, and the rows being nearly 3½ feet apart. The subdivisions in the following tables represent therefore 3 rows 4 rods long, or 1-64 part of an acre. The generally diseased condition of late potatoes which accounted for their higher price in 1903, made it necessary to select the seed more carefully for fall planting, though the work being rushed, the seed of the Rose of Erin which was planted last, was not selected with as much care, and the stand as a consequence, was much poorer than that of the same variety when planted during spring. The loss sustained from this poorer stand was slightly more than offset by the gain from the better stand of the other three varieties, and the principal gain consists in a larger yield of merchantable potatoes due to the earlier ripening from the fall planted seed. The largest gain, as shown below, was obtained from level cultivation as compared

with hilling up, the gain during this, a dryer season, being nearly twice as large as during the preceding wet season. The gain from spraying against blight would have been no doubt much larger had the potatoes been sprayed as often as good practice demands.

The following table gives the time of sprouting and blossoming as well as the time when edible and when fully ripened, the date of sprouting being the time when the rows could be distinguished:

Fall planted.				Varieties.	Spring planted.			
Time of sprouting.	Time of blossoming.	Time when edible.	Time when fully ripe.		Time of sprouting.	Time of blossoming.	Time when edible.	Time when fully ripe.
June 8	July 9	Aug. 24	Sept. 12	Delaware	June 14	July 18	Sept. 1	Sept. 24
" 10	" 12	Sept. 10	" 30	Carman No. 3	" 17	" 20	" 18	Oct. 5
" 8	" 10	Aug. 20	" 10	Rose of Erin	" 14	" 19	" 1	Sept. 24
" 12	" 17	Sept. 8	" 30	Sir Walter Raleigh	" 18	" 24	" 18	Oct. 5

The potatoes were cultivated June 10, 16 and 24, July 5, 12 and 19, the hilling up being partly done July 12 and finished July 19. Those cultivated level received one more cultivation July 25. The vines were sprayed July 1 and 20, and about one-third were sprayed July 23. The yields are given in the following tables:

Table of Fall Planted Potatoes.

Sprayed or unsprayed.	Varieties.	Cultivated level.				Hilled up.			
		Large lbs.	Small lbs.	Yield of plot lbs.	Yield per acre in bu.	Large lbs.	Small lbs.	Yield of plot lbs.	Yield per acre in bu.
Sprayed	Rose of Erin	217	22	239	254[illegible]	193	22	215	229[illegible]
"	Carman No. 3	203	32	235	250[illegible]	189	31	220	234[illegible]
"	Delaware	263	16	279	297[illegible]	253	14	267	284[illegible]
"	Sir Walter Raleigh	328	18	346	369	282	20	302	322
Not sprayed	Rose of Erin	206	28	234	249[illegible]	178	27	205	218[illegible]
"	Carman No. 3	188	30	218	232[illegible]	185	20	205	218[illegible]
"	Delaware	254	15	269	286[illegible]	245	19	264	281[illegible]
"	Sir Walter Raleigh	296	22	318	339[illegible]	273	22	295	314[illegible]
	Total	1,955	183	2,138	....	1,798	175	1,973	....

Table of Spring Planted Potatoes.

Sprayed or unsprayed.	Varieties.	Cultivated level.				Hilled up.			
		Large lbs.	Small lbs.	Yield of plot lbs.	Yield per acre in bu.	Large lbs.	Small lbs.	Yield of plot lbs.	Yield per acre in bu.
Sprayed	Rose of Erin	227	22	249	265[illegible]	192	25	217	231[illegible]
"	Carman No. 3	200	26	226	241	177	30	207	220[illegible]
"	Delaware	244	20	264	281[illegible]	226	31	257	274
"	Sir Walter Raleigh	286	27	313	333[illegible]	276	29	305	325[illegible]
Not Sprayed	Rose of Erin	226	37	263	280[illegible]	196	24	220	234[illegible]
"	Carman No. 3	181	29	210	224	169	48	217	231[illegible]
"	Delaware	240	27	267	284[illegible]	242	29	271	289
"	Sir Walter Raleigh	293	24	317	338	278	25	303	323[illegible]
	Total	1,897	212	2,109	....	1,756	241	1,997	....

SUMMARY OF RESULTS.

Total yield of fall planted	4,111 lbs.
Total yield of spring planted	4,106 lbs.
In favor of fall planting	5 lbs.
Level cultivation	4,247 lbs.
Hilled up	3,970 lbs.
In favor of level cultivation	277 lbs.
Sprayed	4,141 lbs.
Not sprayed	4,076 lbs.
In favor of sprayed	65 lbs.

SUGAR BEETS.

Aside from the usual tests with sugar beets, some preliminary tests were made in order to ascertain the effect upon the sugar content of the beet and upon the beet itself by being left unharvested until spring. A further test was made in order to determine whether such beets would ripen seed. For this purpose a portion of the two plots which had been in sugar beets in 1903 was left unharvested, and as soon as the ground was dry in the spring of 1904 every alternate row of beets was harvested and enough more in each of the remaining rows to leave the beets about two feet apart in the row. The rows were thus left three feet apart, and of the beets which had been harvested, samples were sent to the Agricultural College in order to test the sugar content of the beets, the result being as follows:

Varieties.	Weight when shipped in ounces.	Weight when delivered in ounces.	Shrinkage in ounces.	Percentage of loss.	Sugar content.
Fredericksweriher Elite,	88	80	8	9.99	14.2
Jaensch's Victrix	78	71	7	8.97	15.

As tested at the college during the preceding fall the average tests of fall harvested beets from the same plots was as follows: Fredickswerther Elite 14 8 per cent sugar, Jaensch's Victrix 16.4 per cent. Inasmuch as the sugar content of beets of the same variety, growing alongside of each other and under uniform conditions, varies considerably, it is safe to assume that the test of the spring harvested beets is practically the same as that of the fall harvested beets, and that the sugar content of the beets in this trial was not influenced one way or another by leaving the beets unharvested until spring. No attempt was made to ascertain the influence upon the yield of the beets, for accurate results would have been scarcely possible, considering the small size of the plot. In the present trial it was observed that the crown of a few beets was diseased, thus requiring the cutting away of from one to two inches more than is necessary with beets to be delivered at factories during fall. With more available land for extensive trials, it will be possible to determine whether such a loss is due to a disease which could be rendered harmless by spraying. That the damage was not due to the action of frost was plainly apparent from the fact that the soundest beets were those whose crowns had been more or less exposed owing to the shifting or melting of the snow having carried away some of the top soil. The beets left for seed started a new growth of leaves before the snow had entirely melted away from the plot, and began to blossom July 13 when the seed stocks were about three feet high. The seed on the lower half of the stocks began to ripen during the latter part of August, but the plants continued to grow and blossom, and averaged seven feet high when the tops were damaged by frost on September 22.

The branches were very numerous and the tangled growth prevented much of the seed from ripening. Growing as rank as they did, each beet would have required a space of at least 4x4 feet. About two-thirds of the seed was bright and well ripened.

Eight rows of 100 feet each and 18 inches apart were planted during the past season with the variety Jaensch's Victrix. The seed was planted May 9 and owing to the following wet weather the plants were very slow in coming up, none being visible at the end of the month. It was June 9 before the rows were fully discernible, and June 28 before the plants were large enough for thinning out. About one-third of the plot was much lower than the rest, and the beets were irregular in stand and size, the stand on the lower ground being deficient and the beets remaining undersized. The beets ripened uniformly however, and the yield of the plot in trimmed and topped beets was 560 lbs. or at the rate of 20,328 lbs. per acre. Samples to be tested for sugar were sent both to the Agricultural College and to the Menominee River Sugar factory with the following results:

Where tested.	Weight when shipped in ounces.	Weight when delivered in ounces.	Shrinkage in ounces.	Percentage of loss.	Sugar content.
Agricultural College	72	61	11	15.27	18.8
Menominee River Sugar Factory	62	61	1	1.61	15.

CARROTS, TURNIPS AND SUNDRY ROOTS.

The seed like that of the sugar beets was very slow in sprouting, though a perfect stand was secured for all varieties except the mangles and garden beets. Owing to the favorable weather which began soon after the first of June, it was possible to give the plants more frequent cultivation than during previous seasons, and the heavy yield which resulted was mainly due to the constant stirring of the soil. In order to get more accurate results for comparative yields, all varieties were planted close together without leaving any extra space or path between the plots. Two to six rows of each variety were planted, and owing to the unequal size of the sides of the plot, the figures giving the size of the plots in the following table, represent the number of running feet which each plot would have occupied had it been planted in a single row. The rows of carrots were 16 inches apart, those of mangels and rutabagas were 24 inches, and all others were 18 inches apart. Upon the lower portions of the plots, rutabagas were considerably damaged by maggots, while the tops and those of Kohl Rabi were damaged by the cabbage aphis. The damage from the aphis seems to increase each year, and wherever an up to date spraying outfit is at hand, spraying is highly advisable. With hand sprayers, it is doubtful whether the work would be profitable, especially if it would have to be done while neglecting more important sprayings.

The following varieties are deemed worthy of note:

Carrots—Early French Forcing, small, globular shaped and orange colored. Like the *Short Horn*, is valuable for being early. The roots were ripe August 2. *Improved Short White*. Long, slender roots, skin and flesh white. Sweeter than the orange colored varieties, but lacking flavor. *Milwaukee Market*, stump rooted, half long, light orange colored and medium early ripening variety. No difference could be observed between this and the well known *Danvers California Mammoth Orange*. Long tapering roots averaging 8 inches. Dark orange colored flesh with yellow core. Sweet but coarse and better adapted for stock feeding. *Giant Yellow*, advertised as a new variety with extravagant claims for size and yield. About ten per cent were long tapering roots of a dark yellow color, and size nearly as large as the California Mammoth. The balance consisted mostly of Ox Heart carrots with other varieties of the Danvers type. No difference whatever could be observed between *Maud S.* and *Mastadon*, a white stock carrot with long tapering roots, the upper portion being green colored. *Nantes half long*, not shown in the following table, was planted May 19, the seed being the slowest to sprout.

The plants all came up July 5-7 and turned out to be a poor variety of celery.

Rutabagas and Turnips. Rhode Island Rock, a white rutabaga with green top overlaid with purple. Foliage small and tops nearly neckless. Long tapering tap root, nearly globe shaped but inclined to grow rough. Flesh white, firm, not sweet. *Extra Early Red Top Milan* is the common Purple Top Strap Leaf variety, and for table use is at its best 50 to 60 days after planting. *Extra Early White Milan* is the same variety without the purple coloring. *Purple Top Globe* is another strap-leaved turnip, as early as the last two and more desirable owing to its smooth and perfect globe shape. *White Egg.* The seed was mixed but the specimens true to name are attractive for being true egg shape. An early strap-leaf turnip with small top, permitting close planting and remaining in season longer than the flat shaped varieties. *Large Yellow or Amber Globe*, a strap-leaf turnip, ripening in late summer and of better quality than either the white or purple top varieties. Color dark lemon, flesh sweet and very firm. Depressed globe shape, perfectly smooth, with a very small, abruptly terminating tap root. Will give a very large yield if allowed to grow full size for stock food. Single specimens measured 32 inches in circumference. *Yellow Stone* is practically the same as the last described variety. *Improved Long Island*, a rutabaga differing from Rhode Island Rock above described in the yellow color of the skin and flesh. Is sweeter, somewhat larger and of smoother shape. The tops are larger and neck more prominent. The seed was mixed, about one-quarter being purple top sorts. *Carter's Hardy.* Skin yellow with purple top merging into dark pink. Size medium, mostly smooth with small abruptly terminating tap root. A good table variety with firm and sweet yellow flesh, and one of the best rutabagas for winter keeping. *Improved Vassar*, a yellow fleshed rutabaga of large size. Tops green, partly overlaid with purple. Long tapering tap root. Nearly neckless and of good shape when smooth. Most of the roots were rough however. *Perfection White Swede.* The only rutabaga ever tested here which is perfectly free from necks. Medium to large size. White with green top partly overlaid with purple. Most of the roots were rough shaped and this together with being white fleshed, makes the variety less desirable for table use. *Prize Winner*, a common purple top and yellow fleshed rutabaga which owing to its large size, is best adapted for stock feeding. Of the mangles *Improved Dignity* and *Leutowitzer* are identical with *Improved Mammoth Long Red. Giant Feeding* and *Lane's Improved* are more desirable, being varieties of sugar beets, hence sweeter. Both having smaller roots than the common mangles, would no doubt give a larger yield when planted closer. *Magnum Bonum* is a common hollow crown parsnip which ripened early and is of poor quality. *Sweet Marrow* and *Delmonico* claimed to be new varieties were but slightly better. *Long White Dutch or Sugar* is an excellent variety of superior quality and the best of any which have been tested heretofore.

Table Beets.—Detroit Dark Red Turnip. A medium early variety of good keeping quality. Flesh fine grained and in alternate layers of dark and light red. Leaves of a glossy dark green with red stems and veins. Nearly globe shaped with single small tap root. *Sterling* largely resembles the last, the leaves being of a dark purplish green color. The yields are shown in the following table:

Varieties.	Length of row in feet.	Time of planting.	Yield of plot in bushels.	Yield per acre in bushels.
Carrots Victoria	297	May 12	7¾	852½
" California Mammoth Orange	165	" 20	4	820⅝
" Chautenay	285	" 4	5½	630⅜
" Ox Heart	285	" 4	5¼	601⅞
" Milwaukee Market	285	" 4	5¼	601⅞
" Improved Short White	297	" 12	8	880
" Early French Forcing	285	" 4	5	573⅛
" Maud S.	264	" 23	8¾	1,082¾
" Danvers	132	" 14	3¼	804⅜
" Long Orange Belgian	132	" 14	2	495
" Giant Yellow	132	" 13	2¾	680
" White Belgian	132	" 13	2¼	556⅞
" Mastodon	132	" 13	3¾	928
Turnips Large yellow or Amber Globe	231	" 12	12	1,508⅓
" Purple top Globe	231	" 16	4½	565½
" White Egg	264	" 16	7	770
" Long Cowhorn	264	" 18	13	1,430
" Yellow Stone	132	" 13	7	1,540
" Extra Early Red Top Milan	132	" 12	3½	770
" Extra Early White Milan	132	" 12	3½	770
Rutabagas Sweet German	264	" 16	8	660
" Rhode Island Rock	132	" 13	6	990
" Perfection White Swede	264	" 20	8	660
" Improved Long Island	264	" 14	12½	1,031¼
" Carter's Hardy	264	" 20	10	825
" Improved Vassar	132	" 14	6½	1,072½
" Vaughan's Improved	132	" 14	6¾	1,114⅜
" Prize winner	132	" 14	7	1,115
Parsnips Magnum Bonum	198	" 6	5¼	770
" Marrowfat	150	" 9	4	774⅖
" Delmonico	330	" 19	6	528
" Sweet Marrow	198	" 19	4½	660
" Long White Dutch or Sugar	264	" 20	5½	607½
Kohl Rabi Large Green	150	" 18	3¾	726
" Purple Goliath	150	" 18	4	774⅖
" King of the Earlies	150	" 18	4½	871⅕
" Purple Vienna	150	" 18	5	968
Mangels Giant Feeding or half sugar Mangel	475	" 17	9	412⅔
" Eckendorfer Yellow	340	" 19	7½	480⅓
" Leutswitzer Red	360	" 18	5½	332¼
" Golden Tankard	360	" 18	5½	332⅔
" Improved Mammoth Long Red	360	" 18	5¾	347⅞
" Improved Golden Tankard	360	" 18	5	302½
" Improved Dignity Red	360	" 18	8	484
" Lane's Improved	285	" 17	6½	477
Beets Crimson Globe	150	" 6	2	387 1-5
" Chicago Market	150	" 6	2	387 1-5
" Detroit Dark Red Turnip	150	" 9	2	387 1-5
" Market Gardener's	150	" 9	2	387 1-5
" Sterling	450	" 17	5	322⅔
" Improved Long Dark Blood	380	" 16	5½	420⅓

GARDEN VARIETIES—PEAS.

The early varieties have nothing to recommend them except their earliness and the short vines which enable them to grow without brush or other support. The later the variety, the better the quality, is a general statement which applies to all varieties tested up to the present time. For harvesting before maturity, either for table use or for canning purpose, all varieties have given unusually good results and have been uniformly free from disease and insects. With more available room, ripening tests will be undertaken in answer to frequent requests for information as to whether the varieties are profitably adapted for growing in a commercial way for seed houses in southern localities. The general demand seems to be for northern grown seed, and it has been deemed essential to begin the investigation by ascertaining, 1st, whether the composition of the peas is influenced by climatic conditions, and 2d, whether this influence, if existing, is

transmitted to the seed, and by the seed to the following crop. Quality rather than quantity, is the standard by which the consumer measures the value of this crop, and as such the value is influenced by flavor and sugar content. The fact that flavor cannot be measured with instruments is of secondary importance with this crop, for taste has learned to recognize that the varieties which are sweetest are those with the best flavor, and that a poor variety cannot be materially improved by artificial sweetening when canning it. That the sugar content may be influenced by climatic conditions seems at least probable when considering the results of sugar beet investigations. In order to ascertain the extent of this influence, some analyses of early and late varieties were intended to be made during the past season, the varieties to be used for such purpose being Premium Gem, a medium early variety, and Teddy Roosevelt, a late variety. Unfortunately, the variety bought for Teddy Roosevelt, although sold and marked as such, proved to be a common short podded variety.

Among varieties tested for the first time, the following are deemed worthy of note: *New Dwarf Champion*, the largest of the second early varieties. Peas sweet and of good quality. Vines stout with dark green foliage. *Dwarf Telephone or Daisy* has nothing to indicate any relation to the standard Telephone variety. The peas are small, though fairly sweet for a medium early variety. *Premium Gem* is a week earlier than the last, the vines are more prolific, the peas are larger and fully as sweet. For quality *Thomas Laxton* is one of the best of the medium early varieties, but the least prolific. The pods are scattering but well filled with large sweet peas. *Admiral Dewey* also lacks in prolificness but makes up somewhat for the greater size of the pods which are well filled with large peas of good quality. *Iowa Challenge* as one of the first edible of the medium early varieties is very prolific, the short pods being invariably well filled, though the peas are not as sweet as those of *Surprise*, a variety whose shorter vines are nearly as prolific. The peas of both of these two varieties are of good size. For a profitable variety of fairly good quality, *Nott's Excelsior* is the best of the medium early varieties which have been tested so far. *Improved Stratagem* is the largest podded of the late varieties and the quality is excellent. Is claimed to be an improvement on the old Stratagem variety which is a shy bearer. The claim is not substantiated, for the pods are scattering though usually well filled with very large peas. *Sander's Marrow* is as good as the last for fine quality. The pods are not always well filled, but being more numerous, and the peas being equally as large, the variety is more profitable. A further description of the varieties will be found in the following table:

Varieties.	Time of planting.	Time of blossoming.	When edible.	Length of vines in inches.	Length of pods in inches.	Number of pods per vine.	Number of peas in pods.	Quality.
Alaska	May 5	June 18	July 12	42	2½	6-10	4-6	Fair
Extra Early	" 5	" 19	" 12	42	3	6-10	5-7	Fair
New Dwarf Champion	" 5	July 1	" 22	32	3½	6-12	5-7	Good
Premium Gem	" 5	June 30	" 25	36	3	8-12	4-7	Fair
Dwarf Telephone or Daisy	" 14	July 7	Aug. 1	30	3	5-12	5-7	Fair
Improved Stratagem	" 14	" 10	" 2	30	4	5-8	6-9	Very good
Sutton's Excelsior	" 14	June 23	July 20	22	2½	4-6	5-7	Fair
Admiral Dewey	" 14	July 1	" 31	48	3½	5-7	6-9	Good
Sander's Marrow	" 13	" 9	Aug. 5	42	3	6-12	4-6	Very good
Thomas Laxton	" 13	June 20	July 23	42	3	5-7	5-6	Good
Nott's Excelsior	" 13	" 23	July 22	24	3	5-12	4-7	Good
Iowa Challenge	" 13	" 21	" 20	42	2½	10-12	4-7	Fair
Surprise	" 12	" 21	" 20	30	2½	7-10	4-6	Fair

BEANS.

For snap beans the early varieties are giving good satisfaction, and they wax better than the green pod varieties. Pole beans as a rule are too late to be profitable, and aside from the well known *Scarlet Runner*, only the early ripening of the yellow pod varieties have given good results. *Two Colored Fire Bean* is a promising pole variety, a little later but nearly as hardy and as ornamental as Scarlet Runner. The blossoms are white with the standard a bright pink. *Currie's Rust Proof Wax* is the most prolific of the bush varieties tested. The varieties are described in the following table:

Varieties.	Time of planting.	Time of blossoming.	When edible.	Height of bush in inches.	Length of pods in inches.	Notes.
Currie's Rust Proof Wax.....	June 16	Aug. 1	Aug. 18	14	4½	Pods flat, broad, straight, stringless.
Rustless Golden Wax	" 16	July 31	" 19	12	3¾	Pods flat, slightly curved, stringless.
Stringless Green Pod.......	" 16	Aug. 1	" 24	10	3½	Pods slightly flat, curved, nearly stringless.
Wardwell's Kidney Wax.....	" 16	July 31	" 21	15	5	Pods broad, flat, straight, stringless.
Yosemite Wax............	" 16	Aug. 1	" 22	16	8	Pods broad, nearly straight stringless.
Eight Weeks or July (Pole)..	" 20	" 14	Sept. 3	66	5½	Pods flat, slightly curved, nearly stringless.
Earliest Giant Advance (Pole).................	" 20	" 14	" 1	70	6½	Pods flat, straight, nearly stringless.
Two Colored Fire Bean (Pole).................	" 20	" 4	Aug. 27	50	4	Pods flat, broad, curved, not stringless.
Scarlet Runner (Pole).......	" 20	" 1	" 23	80	4¾	Pods broad, fleshy, curved, not stringless.

Red Kidney and six varieties of field beans did not ripen sufficiently for seed, though the planting, June 17-22 was too late for favorable results. *Henderson's Bush Lima* is the first variety of this kind tested, which produced pods, but no beans developed.

Yard Long, a pole variety did not blossom, nor did *Great German Soup Bean*, a bush variety which had the foliage of a Lima bean. *Dwarf Horticultural* is a promising variety which was expected to ripen and was not tested for its value as a shell bean. The beans were fully developed and nearly ripe.

SWEET CORN.

Of six varieties tested, only two gave favorable results, the earliest being *Peep O'Day* which planted June 10 was edible September 1. The stalks are 4 feet high with small ears 5 inches long having 10 rows of fairly sweet kernels. *Earliest of All* planted June 9 was edible September 3. Stalks 5 feet, ears 7 inches with 14 rows of kernels of good size and quite sweet.

CUCUMBERS AND SUNDRY VINES.

The plants made a good growth throughout the season and blossomed freely until killed by frost on September 22. No damage resulted from the light frost of September 12, but owing to the preceding cold weather beginning with August, the vines set very little fruit and the yield was low. The three which made the best showing were in the order named: *Extra Early Express*, fruit straight, symmetrical, crisp and well adapted for pickles. Color light green shading to white at blossom end. *Early Russian*, fruit dark green, short, thick, oval and covered with small spines. Essentially a pickling variety. *Siberian* practically the same as the last. During seasons such as the past two, it would be advisable, and no doubt profitable, to start the plants under cover, as is done with melons in many localities further south. Thus *Goliath*, being a tender and late variety, was started in the greenhouse of the Negaunee Nursery Co., the plants being received here and set out June 15. The vines blossomed July 14, and specimen fruits 18 inches long were ripe August 19. Of the other varieties tested, *Sterling*, *Cumberland* and *Pickling* gave the poorest yield, while *Jersey Pickling* gave results about one-half as good as Early Russian, the fruit being of medium size, straight, nearly cylindrical, crisp and with prominent spines.

Of the varieties of Musk and Watermelons none set any fruit, though all blossomed beginning August 10, and the latest August 20. Of the squashes, *White Bush Scallop* and *Golden Bush*, two well known varieties, ripened August 28 and September 2, respectively, while *Hubbard* grew to full size, but did not ripen.

TOMATOES.

The results with the tomatoes were slightly better than during the previous season. The vines were heavily loaded with fruit and remained in a thrifty condition until September 22. *Vaughan's Earliest of All* is the most promising variety tested so far, the first fruit being well ripened August 30. A few of the *Atlantic Prize* ripened September 5, and a few of the *Early Freedom* variety were partly colored but refused to ripen completely outdoors. Seed from smooth speci-

mens has been saved with a view of obtaining an earlier and better strain. The small varieties used for preserving ripened much better and in proportion to their small size, *Red Currant*, the smallest, ripening nearly one-half of its fruit after August 10. The other varieties ripened best in the order named: *Ground Cherry or Husk Tomato*, *Red Cherry*, *Red Pear*, *Red Plum* and *Red Peach*. One variety of Husk Tomato (Physalis Francheti) sold as Chinese Lantern Plant, was planted in May, 1903, and at the close of the season had produced numerous short, stocky plants which proved to be very hardy. This variety propagates by underground runners, and the plants came up after the 15th of May, blossoming July 5 and ripening all their fruit before the close of the season. The plants are stout, erect with few upright branches. The bright orange colored fruit averages one inch in diameter, being enclosed in a much inflated husk which frequently attains a circumference of nine inches. When beginning to ripen, the green husk changes from deep orange to bright carmine, the different colors together with the large size of the husks producing a highly ornamental effect. The fruit was found to be bitter, and whether this is characteristic of the variety, could not be ascertained. The plants ware scarcely damaged by September frosts and some of the fruit was still in a healthy condition at the beginning of November.

CABBAGE.

The seed of the two early varieties, *Early Jersey Wakefield*, and *Danish Summer Ballhead* was planted on June 1 in hills 3½ by 2½ feet, all but one plant to each hill being subsequently removed. The plot was located north of the orchard, the soil being a sandy loam of a fair quality. The plants of the other varieties were raised by Fred Greenwood of Manistique, and were set out June 16, the soil being a muck bed 3½ to 4 feet deep resting upon the ledge of calciferous rock which underlies the Station grounds. The plot was partly tile drained during the preceding season when the main vegetation consisted of cat tails and sedges. The muck is friable, free from acid and well adapted for truck crops, the original timber being cedar of very large size with a few scattering black ash. The plowing was delayed until late spring, and owing to the very large quantity of roots and remnants of wind falls which were plowed up, the soil was not in good condition when the plants were set out, and 5 to 15 per cent of the plants either failed to grow or formed small, loose heads. The rows were 3½ feet apart and the plants 2½ feet apart in the row. Cabbage worms were in evidence from early until late in the season the greatest damage being done upon the plot north of the orchard. The other plot was within 20 rods of a bridge on the under side of which several families of swallows had built their nests. Here the worms were exceedingly scarce, for the birds stopped the egg laying of the cabbage butterflies with remarkable swiftness and untiring persistency. The plot not being sufficiently drained, the plants made little progress during September, and 10 to 20 per cent of the heads upon the wettest part of the plot failed to harden up properly. *Danish Summer Ballhead* has none of the characteristics of the Danish Ballhead variety, being dark green with heads slightly flat, but quite uniform in size, well hardened, fairly well blanched, tender and of good keeping quality. *Twentieth Century* is an early variety with solid small heads nearly globular and dark green. *Glory of Enkhousen*, a medium late variety. Heads large, round, closing up well and quite hard. Color pale green and well blanched inside. *Danish Ballhead* proved to be a worthless mixture of at least four varieties, about ten per cent of the plants answering to the description of this variety which is recognized by the bluish cast, the spherical shape, small to medium size and extreme firmness of the heads. *Dutch Winter* is a late variety. Heads small to medium size, round, slightly flattened, solid with outside leaves dark green with red margin. *New Savoy Ironhead* is a very early variety, the heads being uniformly large, pale green, quite firm and tender. *Marvin's Savoy* is medium late, the heads are small to medium size, very firm and of excellent quality. Leaves dark green and very much curled. During this and former seasons it was observed that cabbage worms are scarcely ever found on the Savoy cabbages. *Mammoth Rock Red* is a medium early variety of very large size and excellent quality. The heads are very firm, purplish red outside and deep red to the center. The yields of the varieties are shown in the following table:

Varieties.	Number of heads.	Range of weight of trimmed heads in lbs.	Yield of plot in lbs.	Yield per acre in lbs.
Glory of Enkhousen	250	4½–8	1,580	31,462⅔
Danish Ballhead	150	3½–4½	605	20,079 1-10
Dutch Winter	75	4–5	355	23,563 6-7
Twentieth Century	150	3½–4	560	18,585 4-7
Early Jersey Wakefield	50	4½–5½	252	25,090 4-7
Danish Summer Ballhead	50	3½–4	190	18,917½
Marvin's Savoy	100	1½–2½	205	10,205¼
New Savoy Iron Head	50	2½–3	140	13,939 1-5
Mammoth Rock Red	50	4½–6	260	25,887 1-10

Cauliflower. Two varieties were tested, nearly all plants producing heads of fair size. *Early Snowball* ripens in late summer, the heads being medium to large, solid and of a creamy white color. *Model*, a medium late variety with heads small to medium size, very solid, pure white and very tender.

Celery. The variety *Rose Ribbed Paris Self Blanching* was tested on the same plot with the late varieties of cabbage. Part of the plot was too wet in September and about one-quarter of the plants remained under sized. The plants upon the dryer portion matured well and averaged 24 inches high, being well blanched and free from rust. The seed was poor, for nearly one-half of the stalks were pithy. The rest were crisp, tender, with good flavor and quite free from stringiness. The golden yellow color of the stalks with the ribs a bright pink, give this variety a handsome appearance. *Giant Prague Celeriac* was tested on the same plot. The plants made a rank growth, but the seed was worthless, for no bulbs developed.

Onions. The results with all varieties were practically destroyed by the onion maggot. Judging from the increasing number of letters received askng for relief, it seems evident that the damage from the maggot is of recent origin in the Upper Peninsula, and for two or three years past has been extending over a good share of the territory. It was thought at first that the maggot propagates on the wild leeks which happen to be unusually abundant in the neighboring woods of nearly all localities from which the damage has been reported. Extensive observations during the past two seasons lead to the conclusion that the maggot does not propagate in the wild leeks nor in the cultivated leeks which have been purposely left in the ground over winter. Neither has evidence of their work been discovered on perennial onions which have been planted here in May, 1903, and have been growing unharmed ever since. As it seemed evident from the letters received and from observations taken here that the maggot is being introduced in onion sets shipped in from outside points, about two dozen of the sets, received April, 1904, were wrapped in damp moss, securely tied in strong paper bags and kept warm enough for rapid sprouting. When inspected two weeks after, four of the sets were found to be free from maggots and the others, or 22 had each from 2 to 8 maggots. While no tests were made with top sets, it seems evident from field observations of the past two seasons, that these varieties are more, if not entirely, immune. It is not believed at least that the maggots propagate in the tops of the perennial onions planted in 1903, for about a peck of the tops were gathered during the fall of 1904 with the intention of sprouting about 25 of the sets during each month until the following spring. At this writing two monthly tests have been made, and no maggot has as yet been found. It remains to be determined whether the maggot can be destroyed before planting the sets and without injury to the plants. Of the methods now known for fighting this pest none has proven entirely successful here, nor is any at all profitable with the exception of gathering all cull onions after harvest and destroying them either during fall or very early during the following spring.

Leeks. Two varieties were planted May 5. *Large Musselburg* is a medium early variety. The leaves are broad, erect and pale green. The stalks are tender, bleach well, range from 1 to 1½ inches in diameter and average 15 inches high. *Bulgarian Winter* is a later variety with smaller leaves of a dark green color. The stalks bleach rapidly, average one inch in diameter and 12 inches high. When hilled up for bleaching, leeks may be left in the ground for harvesting during the

following spring, and have never been found damaged any more than carrots or similar roots.

Salsify. *Mammoth Sandwich Island* was planted May 11. The roots are large, white fleshed, tender and quite smooth when planted in a deep, porous soil which contains an ample supply of humus. No better variety has been tested as yet, nor any as good. *Giant*, roots nearly as large as the last, but shorter and prongy.

Kale. The varieties were planted May 18. *German Dwarf Green*. The plants are low and compact, averaging about 16 inches high. Leaves dark green, much crimped, cut and curled. *German Dwarf Purple* answers the description of the last, except that the color of the leaves is a reddish purple. *Excelsior Moss Curled* is a tall variety of dark green color, the plants averaging 28 inches high, the finely crimped and curled leaves having the appearance of bunches of moss. Except for the purple colored leaves, *Purple Vienna* resembles the last. *Purple Ostrich Plume*. The plants average 20 inches high and are somewhat less compact. The finely cut and less crimped purple leaves mark this as a distinct variety and give it a handsome appearance. All these varieties are ornamental enough to adorn any flower garden. Their qualities as a vegetable are practically the same. As tested here, they are excellent when the plants are young, and up to the time when they are 6 to 8 inches high. When full grown, they remain coarse when cooked, and have a pronounced bitter taste. The plants are scarcely damaged by frosts which are severe enough to kill almost any other vegetation.

Collards. *True Georgia* was planted May 18, the plants reaching a height of 24 inches and resembling partly closed cabbage heads. Towards the end of the season the heads closed and became quite solid, averaging about 1½ lbs. As a vegetable, the variety has nothing to recommend it except its hardiness. When cooked, the plants have the taste and flavor of cork, but are more tender.

Lettuce. Owing to the hardiness of the varieties, planting can begin very early, for growth is not materially checked during backward seasons like the past. No disease or insects have as yet been found to damage any of the varieties. The curled or loose leaved varieties are usually of edible size much earlier than the cabbage, or heading sorts. The varieties tested are: *Improved New York, or Wonderful*. Large dark green wavy and crimped leaves, folding closely and forming very large heads well blanched, of excellent quality and remaining in good condition longer than any other variety tested. *Mammoth Black Seeded Butter*. Leaves large, smooth, thick, brittle and dark green, forming solid large heads which blanch well and are crisp and tender. *Black Seeded Simpson*. A loose leaved variety forming large, loose heads of a pale green color. Leaves large, tender, thin, with the edges slightly wavy and blistered. Remains in good condition for a considerable length of time. *All Seasons*, leaves smooth, thick, dark green, heading up very early, tender, crisp and of good keeping quality. *New Morse*. Leaves small, wavy, light green answering the description of Black Seeded Simpson. *Maximum*, a heading variety of good keeping quality. Leaves smooth, dark green, brittle, forming solid heads of a pale straw color and quite tender. *Sterling*. Leaves light green, small, round, blistered forming loose heads of fair quality.

Spinach. This most excellent vegetable is as hardy as lettuce. As tested here, most of the varieties have proven worthless, being evidently due to poor seed, for whether planted early or late, the plants with few exceptions have run to seed before the leaves are scarcely large enough to be of edible size. *New Zeeland*, planted both early and late proved to be one of the worthless varieties. *Norfolk Savoy* gave better satisfaction, the leaves being thick, blistered and curled like those of Savoy cabbage. *Perpetual Spinach Beet Lyon*. The leaves are smooth and smaller than those of the Swiss Chard variety, while their smaller stems are not edible. The same may be said of *Giant Perpetual Spinach Beet Lucullus*, the leaves of which are larger and very much blistered. Owing to the large size of the leaves, these two spinach Beet varieties as well as the Swiss Chard will give a very large yield. The rows should be at least two feet apart, and the plants thinned out to 18 inches in the row. They are tender when cooked, but there is a pronounced absence of taste and flavor.

Radishes. The varieties were slow in developing owing to the wet weather in May, and the quick growing or forcing varieties, planted May 3 were not of edible size before June 15. Later plantings gave better satisfaction, and owing to the quicker growth the roots were clean and free from maggots.

Early Bird planted May 20 ripened June 20. Turnip shaped, small, deep scarlet,

very small tops. Flesh crisp, tender, juicy and mild. *Snowball.* Turnip shaped, medium size, white, tops large and spreading. Planted May 6 and ran to seed almost as soon as edible June 23. The variety is scarcely up to the claim of being "the earliest and tenderest variety grown, ready for use two weeks from sowing." *Short leaved forcing*, planted May 3, matured June 15. Roots small, deep scarlet, olive shaped, crisp and tender. Very small dark green tops. *Hailstone.* Planted May 3, matured June 15. White, translucent, mild and juicy. Globe shaped, small with small spreading light green tops. *Triumph.* Planted May 20, matured June 24. As tested during the preceding season, this is one of the handsomest forcing varieties. The seed not only was not true to name, but proved to be a mixture of four distinct varieties, all of which ran to seed as soon as mature. *Yellow Summer Turnip.* Planted June 16, matured July 20. Medium large, slightly oblong, with long tapering tap root. Dark straw color, flesh white, mild and juicy. *Cincinnati Market.* Planted June 20, matured July 20. Long slender roots growing partly above ground. Deep-scarlet, crisp, tender, juicy and keeping in perfect condition for a considerable length of time. *Improved Early Breakfast.* Planted June 20, matured July 18. Roots small, oblong, bright scarlet and white tipped with small light green tops. About ten per cent were mild, crisp, juicy and of best quality. The rest were pithy and worthless. *China Rose*, a winter variety, planted June 20 ran to seed before full grown. The seed of this and of the Triumph variety came from the same source, and it is regretful that the selling of such stuff should still be considered legitimate business.

Long Black Spanish, a winter variety of large size. Black with very large, spreading tops. Flesh greyish white, mild and very firm. Will keep in good condition until late spring when packed away in dry sand in a cool cellar, or may be left in the ground over winter.

MISCELLANEOUS CROPS AND ORNAMENTALS.

Scolymus as tested during the preceding season, was planted May 12. Very few good roots were secured, as nearly all plants ran to seed early in the season. Sample plants sent to Prof. R. H. Pettit were identified as *Scolymus Hispanicus*, being known as Spanish salsify or golden thistle. When the seed is reliable the roots are valuable as a vegetable, resembling those of the ordinary salsify and being usually less prongy. *Cynara Scolymus or Globe Artichoke* planted in June, 1903, was found in perfect condition when the snow had disappeared. The plants reached a height of 52 inches, were many branched and blossomed August 17. The blossom heads ranged from 2½ to 3½ inches in diameter. The plants, as during the preceding season, were not seriously damaged by frosts when covered by permanent snow towards the end of November.

Mustard. Giant Southern Curled or Chinese, planted May 21, edible June 27 when the plants were about 8 inches high. Leaves broad, curled, light green, tender and with pleasant flavor. Ran to seed when 10 inches high.

Roquette (Eruca Sativa) a rapid growing hardy plant used for salad or as a pot herb. Leaves dark green, smooth, resembling those of radish and with a slightly pungent and agreeable taste.

Rampion (Campanula Rapunculoides). Of slower growth than the last but equally hardy. The small heart-shaped leaves during spring, and the long spindle shaped white roots during fall are used for salad. These two vegetables are seldom seen in cultivation except in France.

Parsley. Fern leaved. The bright green leaves are much cut, crimped and curled. The plants are tall, compact and of fern like appearance, making them valuable for garnishing or table decoration. *Hamburg or Large rooted.* Though the leaves may be used as those of other varieties, the small parsnip shaped root of this variety is more generally used for flavoring soups.

Tobacco. The two varieties tested, *General Grant* and *Connecticut Seed Leaf* have been tested during the preceding season. The plants were again considerably damaged by cut worms, and blossomed August 9 and 17 respectively. The leaves were as well developed, but the seed did not ripen quite as well as in 1903.

Pepper. The Red Cherry variety was tested. The first seed proved worthless, and owing to the delay in securing other seed, the plants were not large enough to set out before July 16. They blossomed August 23, but no fruit ripened.

Sunflowers. Mammoth Russian and *African Giant* reached a height of 12 feet, blossoming August 17 and 31 respectively. The plants of the Russian variety

which blossomed up to August 25 ripened the seed. The others and the black seeded or African variety did not ripen.

Double Chrysanthemum averaged 8 feet high blossomed September 2 and did not ripen. The varieties were planted May 16, and as the plot was shaded on the west side by the timber, and proved to be too wet the plants were still weak at the end of June.

Nasturtium. The Dwarf variety was tested, being planted June 20. The gorgeously colored blossoms remained conspicuous from August 16 to September 22.

Chamomile. The variety Anthemis nobilis was planted May 23. The plants resemble the common May weed, but are more spreading and the leaves being more finely divided and pleasantly strong scented. The blossoms with golden yellow centers and drooping white rays are used as a household remedy for colds or fever. The plants are slow growing but quite hardy.

Honey Anchuse (Anchusa Italica Retz) planted in 1903 is unsurpassed for hardiness. The plants started to blossom May 29, the stout flowering stalks reaching a height of 5½ feet and being covered with great masses of the showy blue flowers until late in November. Humming birds and hordes of honey gathering insects were working on the blossoms throughout the season. If the plants are adapted as well for honey bees, it would be hard to imagine anything equal, much less superior, as a honey plant.

Anchusa Capenis was planted June 20 and blossomed August 25. Turned out to be the same as the last.

Borage (Borago officinalis) name supposed to be a corruption of corago, from imagined cordial properties. The mucilagenous plants are used in some parts of Europe as demulcent and diaphoretic. Planted June 20 and blossomed August 8. The plants are very hardy, useful as a honey plant and ornamental while carrying the loosely racemed handsome blue flowers.

Phacelia, Tansy leaved (Phacelia bipinnatifida) planted June 21 and blossomed August 11. Sold as a honey plant and ought to prove valuable as such. Very hardy and ornamental. The leaves have a fern like appearance, are pale green with the tips and upper parts of the stems frequently purple colored, while the tall flowering stalks are heavily loaded with long, loose and inwardly curving racemes profusely covered with lavender blue flowers.

Siberian Dragonhead, a partly identified species of Dracocephalum, planted June 21 and blossomed August 22. Sold like the last as a honey plant, and ought to prove equally valuable, judging from the continuous work of many species of honey gathering insects. Nearly as hardy as the last.

STRAWBERRIES AND SMALL FRUIT.

For strawberries, the forepart of the season was almost perfect, and the large yield of the varieties would have been still larger had it not been for the hot July weather which shortened the picking season by prematurely ripening the fruit. At the beginning of the season, the plots on sandy loam were enlarged and an additional row of each variety not heretofore tested on the dryer soil was added. The rows set out in 1902 were cultivated twice and mulched with clean straw shortly after beginning to blossom. At the end of the picking season the mulch was removed and stored away, and the plants were given three more cultivations. Owing to the plants being in matted rows, hand weeding was rendered necessary once before and once after picking time. The plants were not sprayed, and most of the varieties showed the damage from rust which seems to be more effective on the dryer ground. As during the preceding season, the damage from cedar birds was merely limited by the scarcity of the birds, the damage being mainly felt owing to the small size of these plots. The few birds which are seen, seem to feed exclusively upon fruit, and destroy several times more than the amount which they eat. On the other hand robins are fortunately very numerous on the Station grounds, and careful observations together with a sense of justice compels the statement that their damage is restricted to the gathering of the seed from a few berries, and this only at a time when their young begin to feather out. This self appropriated and partial compensation, by the selfish termed a misdemeanor, is at least justifiable, for weed seeds at that time of year are extremely scarce, hence necessity rather than choice, compels the partial diet of berry seeds. After observing the worst infestation of cut worms ever witnessed, and the great

work of the robin during the past two seasons in subduing the pest, and after noting the oratorical warfare which is periodically waged against the bird, only the man who is ever anxious to obtain something for nothing could fail to put in a plea for this much abused and underpaid servant.

Four additional varieties were set out in 1903, but as most of the new plants were used for enlarging the plots, the varieties are not included in the following table. The varieties are: *Oregon Iron Clad.* Bi-sexual and strong growing plants. Berries medium to large, conical to wedge shape, dark red, firm and with excellent flavor. Medium late. Blossomed May 27, the fruit ripening June 21. *Texas.* Bi-sexual. Strong growing plants of good size. Berries of medium size, short conical, smooth, regular, dark crimson when fully ripe. Flesh pink, moderately firm, slightly acid and with fair flavor. Medium early. Blossomed May 24, the fruit ripened June 24. *Midnight.* Bi-sexual. Plants very weak. Most of them died and the best made a poor growth during both seasons. Berries medium to large, of irregular shape, conical pointed to broad flattened, mostly ribbed and sometimes necked. Bright scarlet, seldom coloring on the under side. Flesh light pink, very firm, not juicy, but of very good quality. A late variety Blossomed May 28. Fruit ripe June 23. *Mexican Everbearing.* Bi-sexual. Strong, but small plants with fruit stems too short. Berries small, conical, irregular, light crimon, rather soft, sweet, with fair flavor. Medium early variety, blossoming May 21, first fruit ripening June 21. Did not produce any late fruit, nor blossom late, as is claimed for the variety.

Nearly all varieties seem to be better adapted to the loamy soil. Sample being a conspicuous exception. The improvement noted with Marshall and Michigan is not sufficient to indicate that the plants of either variety will prove to be of even average productiveness. The yield of the varieties is shown in the following table. Each variety occupies one row fifty feet long:

Varieties.	Sex.	First blossom.	First ripe fruit.	Last ripe fruit.	Yield of plot in quarts.	Yield per acre in quarts.
Excelsior	Perfect	May 17	June 18	July 14	29	6,316 1-5
Success	Perfect	" 19	" 22	" 16	25½	5,553 9-10
Bederwood	Perfect	" 18	" 20	" 16	48	10,454 2-5
Glen Mary	Perfect	" 20	" 24	" 18	32½	7,078 1-2
Haverland	Imperfect	" 21	" 24	" 18	36	7,840 4-5
Sample	Imperfect	" 28	" 28	" 14	27	5,880 3-5
Parker Earle	Perfect	" 21	" 28	" 16	14	3,049 1-5
Clyde	Perfect	" 20	" 23	" 19	24	5,227 1-5
Brandywine	Perfect	" 24	" 24	" 18	23	5,009 2-5
Marshall	Perfect	" 19	" 23	" 18	9	1,960 1-5
Gandy	Perfect	June 2	July 1	" 24	9½	2,069 1-10
Michigan	Perfect	May 28	" 1	" 24	7½	1,633 1-2

The original plots planted in 1900 were too wet to be cultivated, the ground not being dry enough to hold up a horse until June 11, when the blossoming season was practically over. Eight rows upon the slightly dryer portion on the south half of the plots were weeded by hand, while the balance was hand mowed to keep the weeds from going to seed. The mowing was not done carefully enough to save most of the plants, and the results from the eight rows are shown in the following table. That the soil is well adapted for strawberries when properly drained, will seem evident from the results when considering the age of the plots and their extreme wet condition since laid out. The plots were plowed early in July and fitted for winter wheat:

Varieties.	Length of row in feet.	Sex.	First blossom.	First ripe fruit.	Last ripe fruit.	Yield of plot in quarts.	Yield per acre in quarts.
Sample	1,140	Imperfect	June 1	July 2	Aug. 3	408	3,897 1-2
Bederwood	460	Perfect	May 21	June 24	July 25	190	4,498
Gandy	135	Perfect	June 4	July 5	Aug. 5	27	2,178
Michigan	760	Perfect	" 2	" 4	" 5	30	429 6-7
Brandywine	200	Perfect	May 28	June 27	July 25	28	1,524 3-5
Glen Mary	30	Perfect	" 23	" 27	" 25	8	2,904
Mayflower	135	Perfect	" 22	" 21	" 20	12	968
Bryant	180	Perfect	" 26	" 29	" 25	24	1,452

Owing to the impossibility of giving timely cultivation and the extreme difficulties under which spraying operations had to be carried on, anthracnose, mildew and currant worms have left extremely few of the fruit bushes in a condition fit for fruiting. Cultivating too late in the season for several years has caused the roots of the bushes to grow too close to the surface, and when on June 11 the ground was dry enough to use the horse cultivator, it was found that the work had to be abandoned, the bushes being killed almost as soon as cultivated. That the strawberry plants upon adjoining plots have been able to withstand the unnatural conditions as well as they did speaks perhaps for the climatic conditions of this region which seem to favor this crop, though in a large measure this is due to the different growing habit of the plants, their greater freedom from insects and diseases, and especially to the greater depth of soil upon which the plots were located. The behavior of the varieties under these adverse conditions has been such as to give promise of favorable results whenever they can be given the cultivation and spraying which every successful fruit grower knows to be indispensable.

ORCHARD.

The severe conditions of the preceding winter left their impression upon some of the varieties of all orchard fruit. The cold weather was unusual in persistency rather than intensity, though the damage occasioned was due rather to heat than to cold, resulting in what is commonly termed as sunscald. Up to the snow line, or about 2½ feet above ground, no tree was damaged. Above that several varieties were injured more or less on the south side, dead bark subsequently resulting, from merely a few spots in the tops to the entire south half of the trees. With few exceptions the damage was greatest as the exposure to the rays of the sun was greatest, the trees on the southern slope of a knoll faring worse than those on the opposite side. The damage was done during the few days of the middle of December, forepart of January and last of February, when zero weather and high temperatures sharply succeeded each other. There is ground for assuming that future experiments may show that such damage can be avoided by simple means. Fruit buds of hardy varieties were also damaged to some extent, this also occurring on the south side of the trees, and more upon southern slopes than elsewhere. The more seriously damaged varieties which were subsequently cut off are Mann, Wagener, Baskoop, Dr. Walker, Ontario and Canada Red of the apples, Moore's Artic of the plums, Vermont Beauty and Bessamanka of the pears. Cover crops have as yet not been used in the orchard, and this no doubt aggravated the damage, for the forepart of the fall season was wet, the latter part was quite warm, and the sap was more active than usual when winter set in. Though effective spraying, even at the expense of a great amount of labor, is scarcely possible any longer with a hand outfit, there was no difficulty in keeping disease and insects fairly well subdued. Scab under existing conditions, is hardest to control, while shot hole fungus, the only other disease observed, was merely persistent on the trees of the Forest Garden variety, the trees being the tallest, hence hardest to reach with a hand pump. Were it not for the aphis, spraying for insects could be well dispensed with, for nests of wrens, gold finches and several species of sparrows are very numerous in and around the orchard, and the few insects which escape the attention of the birds are not numerous enough to cause any damage. One spraying at the time the buds were well opened was sufficient to dispose of the first brood of aphis. The second brood during July could not be entirely controlled, as the aphis multiplied faster than they could be killed by spraying, for when the leaves begin to curl up, it is slow work to reach the insect even with a power pump. The spraying mixture consisting of one pound of laundry soap and one pound of tobacco stems to eight gallons of water has proved effective when used fresh. If allowed to stand until it begins to ferment, the mixture is of no great value. As during former seasons high winds from the south maimed or broke down several trees, the orchard being unprotected on that side and being located on a slope which affords unusual destructive powers to southerly winds. The trouble with all cherry trees, as related in Bulletin No. 28, continues unabated, and while all the trees ripened some fruit, it is not expected that many of the trees will be alive next season. Six of the trees were dug up and sent to experts for examination. Like those dug up during the preceding season, the trees were found diseased about two inches above and two inches below the point where the scion was grafted into

the root, the root system and the top of the tree being in a healthy condition. Whether the trouble is due to improper grafting or to some local soil condition has not been definitely settled at this time. The American varieties of plums were heavily loaded with fruit which remained in a partially ripened condition from the latter part of August until damaged by September frosts. Shrop Damson is the only variety which ripened well though the trees were last in blossoming and had been damaged by sun scald during the preceding winter.

Most of the varieties of grapes made a growth of six to eight feet, and five varieties were in bearing. The fruit was well colored toward the end of August, but owing to cold and wet weather failed to ripen properly. Six varieties of apples blossomed for the first time but failed to ripen the fruit, the few apples being blown off by wind storms when about three-quarters full grown. These are: *Aitken's Striped*, blossomed June 7; *Gideon No.* 29, Blossomed June 9, *Patten's Fameuse*, blossomed June 9; *Longfield*, blossomed June 8; *Tetofsky*, blossomed June 10 and *Whitney* (*crab*) blossomed June 7.

The seven varieties which ripened fruit are *Haas*, *Borowinka*, *Gideon*, *Hibernal*, *Patten Greening*, *Yellow Transparent* and *Duchess*. A considerable percentage of the fruit buds of the first three varieties were winter killed. Some of those of the other varieties were too weak and failed to set fruit. The description of these varieties follows: *Haas*—blossomed June 6, sometimes called Fall Queen. A seedling from Missouri. Very strong, upright growing tree Fruit medium size, roundish oblate, conical, skin thick, tough, yellow overlaid with crimson splashings and stripes, dots few, white, minute and obscure. Basin narrow and abrupt. Stem short and stout. Cavity acute and russeted. Flesh white, sometimes stained red near skin, juicy, subacid and of fair quality. A late fall apple. *Borowinka* blossomed June 11. Of Russian origin. Tree very short and round headed. Fruit medium size, roundish, truncated. Skin greenish yellow covered with crimson stripes and splashes mixed and marbled on sunny side and overlain with whitish net veining. Dots obscure, few, white. Basin abrupt. Stem medium and stout. Cavity deep, wide, slightly russeted. Flesh white, juicy, sprightly acid and of good quality. Season late fall. *Gideon*, blossomed June 1. As grown here the variety is not the Gideon and was not fully identified. The tree is stout and very spreading. Fruit very small, roundish oblate, conical. Skin yellowish white, mostly overlaid with crimson splashes and stripes washed when fully exposed to sun. Dots minute, few, obscure. Basin abrupt, slightly wrinkled. Stem medium and slender, cavity acute, wide, regular. Flesh white, subacid, juicy and of good quality. Season early fall.

Hibernal, blossomed June 4. Of Russian origin. Sometimes called Yellow Arcadian. Tree vigorous and very spreading. Fruit large, roundish oblate, conical. Skin greenish yellow, bronzed with red and crimson splashes where exposed to the sun. Dots obscure, minute, white, sometimes russet. Basin narrow, wrinkled, shallow. Stem short and stout. Cavity deep, regular, russeted. Flesh white, acid, juicy, slightly astringent and of good quality for cooking purpose. A fall variety and one of the hardiest trees on trial.

Patten Greening. Blossomed June 6. A seedling from Iowa. Tree vigorous with spreading top. Fruit large, roundish oblate, irregular, slightly angular. Skin yellowish green with bronze blush. Dots minute, white, and surrounded with green or shaded side. Basin broad, abrupt, slightly corrugated. Stem very short and stout. Cavity acute, wide, russeted. Flesh white, juicy, subacid and very good quality. An early winter variety and tree very hardy.

Yellow Transparent. Blossomed June 6. Of Russian origin. Tree stout, upright, with round top. Fruit large, roundish conical, slightly angular. Skin yellowish white, smooth, transparent, dots, large, white, obscure, basin shallow, narrow, corrugated. Stem medium and stout. Cavity obtuse, wide, russeted. Flesh white, juicy, tender, sprightly subacid and of excellent quality. A late summer variety.

Duchess. Blossomed June 7. Usually called Duchess of Oldenburg. Of Russian origin. Tree vigorous with spreading top. Fruit large, roundish oblate, regular. Skin greenish yellow, almost wholly covered with stripes and splashes of crimson, mixed on sunny side. Dots minute, white and numerous. Basin abrupt, broad and regular. Stem short to medium, slender. Cavity deep, acute, russeted. Flesh white, juicy, sprightly acid and very good quality. A fall variety.

INVESTIGATION REGARDING SUCCULENCE.

F. W. ROBISON.

[Special Bulletin No. 32.]

INTRODUCTION.

From time to time during the last thirty years a number of experiment stations have compiled data from experiments bearing on the subject of animal nutrition. These have largely taken the form of digestion experiments dealing with various feeds peculiar to a particular locality or relating to the more common American feed stuffs. Practically, the sole aim of such experiments has been to determine the per cent of digestible protein, etc., in the various feeds, and, as a result, feeders and stockmen throughout the country have learned to look to the *digestible dry matter* of a feed instead of the total amount of nutrients in the feed when comparing its merits. It has long been known that the domestic animals were unable to utilize completely any of the common feed stuffs, and it has been considered very apparent that the value of a feed to an animal depends not only upon the quality and amount of food consumed, but also upon the amount excreted in the feces and not utilized by the animal's system. Consequently data bearing on the digestibility of the various feeds available have been welcomed by feeders throughout the world and there is now at their disposal the digestive coefficients of nearly all the common feeds.

With the beginning of the investigations on the maintenance ration for steers by Kellner and other European investigators, and in this country by Armsby and others, a suspicion has been creeping gradually into the minds of more advanced feeders and scientists that the story as told by the digestion experiments was incomplete, and with the further progress of respiration experiments on man and animals this suspicion has been more or less confirmed.

Much discrepancy has arisen from the too rigid application of the balanced ration, and while its great importance is still undisputed there are factors that enter in to modify and in some instances to counteract its effect. To make more specific, two rations are compounded having the same nutritive ratio, or, in other words, constituting rations in which the relations between the proteids, carbohydrates and fats are identical. It is found on actual trial that these two rations are not equal in value, not because they are not equally digestible, but because some factors other than nutritive ratio and digestibility have entered in to modify the effect in question.

The ultimate object of the consumption of food is the production of energy.

In giving feed to a horse it is desired to convert the inert material into energy which manifests itself in some form of motion. In giving feed to the dairy cow it is likewise desired to convert the same into energy which manifests itself in preserving the mechanism of the animal's body and in providing human food, which latter is finally converted into the energy of maintenance and of motion in the human body. It is readily conceded that movement of any kind is a manifestation of energy in the animal's body and can be traced to but one source, and that, evidently, the food consumed.

All processes in the body then require the expenditure of energy, the beating of the heart, movement of the blood, phenomena of digestion, of absorption and of excretion; movement of the food in the alimentary canal, mastication or chewing of the food, etc., all require the expenditure of energy, and research has shown also that it is no inconsiderable amount of energy thus expended. It is clear that if the chewing and digestion of food require the expenditure of energy, the form and preparation of the food must make some difference in the gross amount of energy expended by the animal. Quite recent experiments have shown that

the above is true, and further that the amount of energy expended in chewing and preparing food material for solution in the body is much different with different foods. It must also be clear that such factors as *crude fibre* in a ration have much influence on this point.[1]

A food then is of value to the animal, not in proportion to the gross amount of nutrients contained therein, but to the energy available after deducting from the digested portion the amount which has been expended in the various physio-chemical processes involved in making that food an intergral part of the animal body. It must be true also that a digestion experiment, in which the difference between the gross amounts of nutrients in the food and in the dried feces is taken as a measure of the value of that food, is not wholly reliable because the expense to the animal of the digestion and absorption of that food is not clearly shown.[2]

It has been the custom, heretofore, to take the difference between the amount of nutrients in the food and the dry feces as being the amount of nutrients in the food digested and utilized by the body. This method left out of consideration two quite important factors. A not inconsiderable amount of nitrogen is lost by even the air drying of the feces and hence the computation of digestibility on the basis of what nutrients remain in the dry feces places the figures for digestibility too high. Again, there has been shown to be a considerable amount of nitrogenous matter in the feces remaining after drying and bearing but an indirect relation to the food consumed. This nitrogen, together with the nitrogen lost on drying, may be considered a waste product from the juices and linings of the intestinal canal, and from the various body fluids, and represents in part the *cost* of the digestion of that particular food. This is called *nitrogen of metabolism*. The effect on the figures of digestibility of the nitrogen of metabolism in the dry matter of the feces is to lower the apparent per cent of digestible nitrogen in the food. The fact, however, that the nitrogen of metabolism in the dry matter of the feces has been taken into consideration in establishing our ordinary coefficients of digestibility while the nitrogen lost on drying has been almost entirely neglected, makes clear that the factors of digestibility *as formerly determined* are too high by just the amount of metabolic nitrogen lost in the drying of the feces.[3]

We take note, then, of *net available energy*, or that remaining after subtracting from the total energy of the digested food the energy due to metabolism or that which constitutes in part the cost of the digestion of the given food to the animal, plus the energy of the real undigested food. It is somewhat evident, it is true, that while the separation of the nitrogen of the feces into nitrogen of metabolism and nitrogen of undigested food gives a clearer index to the actual per cent of digestibility of the food, at the same time where no such separation is made the figures of digestibility may be said to represent in part the net availability of that food, provided the nitrogen lost on drying of the feces is taken into account.[4] However, this permits of no comparison of different foods, for even though they apparently contain the same amount of digestible matter the cost of the digestion of one may be considerable more than of the other, and there is no indication in such results that would permit of the economic comparison of the two different feeds.

It has been demonstrated[5] that the burning of tissue in the body and that the liberation of energy to promote the work of digestion and assimilation varies in different foods, and foods *difficult of digestion* require the consumption of more body tissue in the effort to digest them. *If it be true* that an increase of cell oxidation is accompanied in food digestion by an increase in the metabolic products in the feces, then a knowledge of the amount of these metabolic products in the feces is an indication of the real value of the food not otherwise indicated. It

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1. It is a well known fact that foods rich in crude fiber or roughage material are subjected to more prolonged action in the gastro-intestinal canal of ruminants than are the concentrates with a small amount of crude fiber. In fact ruminating animals, if fed wholly on concentrates lose the power of ruminating the food which, of course, indicates that the period of contact with the body fluids is shortened.

2. Nearly all the present digestion coefficients are based on the dry matter of the feces without attempt to separate the various products present in the feces a considerable amount of which bear no direct relation to the food consumed.

3. See Penna. Report, July 1, 1900—June 30, 1901. W. W. Cooke, pp. 273—274. It seems quite evident from our experiments that the amount of metabolic nitrogen excreted does not depend upon the dry matter of the food but upon other factors in the food.

4. Ibid, page 274. It is assuredly unsafe to assume that the nitrogen lost on the drying of the feces is sufficient to balance or counteract the influence of the nitrogen of metabolism remaining after drying. It does not vary with the latter and therefore if we desire to establish the approximate net availability of a food the results are too high unless we take into consideration the nitrogen lost on drying which is sometimes considerable and again may be of little note.

5. See Armsby's Principals of Animal Nutrition, "comparison of hay and grain."

has been shown that the expenditure of energy on coarse fodder is greater than on grain. It seems plausible to suppose, as Armsby suggests, that this increase in expenditure is due, in part at least, to the greater per cent of crude fiber in the fodder. Certainly looking at the matter from the standpoint of the metabolic products in the feces, it seems highly probable that foods containing a higher per cent of crude fiber are digested at greater expense than foods with less crude fiber. There may be, however, other points to modify the above and it was to observe its effect as well as to note the general influence of succulence that the experiments recorded herein were undertaken.

For the last few years sugar beet pulp has been available to feeders in this State and it was decided to use this product in determining the effect of succulence on metabolism and on the various factors of digestibility in an otherwise dry ration. Accordingly, in the winter of 1902-03 two young Jersey heifers were selected from the college herd, through the courtesy of Professor Shaw, and fed on the following rations during a period of three months. The basal ration consisted of clover hay, oat straw, bran and corn and cob meal, compounded in such a proportion that the nutritive ratio of the same was 1 to 12.2. By preliminary feeding it was found to be possible to keep the animals approximately in maintenance on a ration of the above ratio and at the same time a possible error when changing later to sugar beet pulp was avoided. The sugar beet pulp used in the experiment had a nutritive ratio throughout of 1 to 12.2. The observation periods were four in number, each period being preceded by a preliminary feeding period of at least two weeks. During this preliminary period the animals were allowed some exercise except for the last few days, and it was not found difficult to accustom the animals to the new food during this preliminary feeding. During the actual observation period the animals were under observation night and day, during which time the food and excrement were weighed, sampled and analyzed daily. To avoid chance of variation in weight of the food from day to day, due to variations in the hygrometric state of the atmosphere, the food for the entire period was compounded, weighed, sampled and put in paper sacks at the beginning of the experiment. The feeding problem was thus rendered very simple, for at each meal it was only necesasry to take a sack from its place and give the animal its contents. Any uneaten residues were weighed and sampled daily.

During the first period the two animals were kept simply on the basal ration. At the end of the first period, which lasted seven days, the animals were given some exercise and the ration gradually changed. Wet sugar beet pulp was now introduced and the dry matter of the basal ration was reduced by just the amount of dry matter in the beet pulp. The nutritive ratio remained constant throughout. With a preliminary period of two weeks on this new food the animals were again placed under observation as in period one. The same procedure was followed in period three, except that the basal ration remained the same as in period two and the amount of sugar beet pulp was raised, giving the animals as much as they would consume. The purpose of this third period was to determine the effect of a full ration in comparison with a maintenance ration. Period four was the same as period one, namely, simply the basal ration without succulent feed

The experiment was repeated during the winter of 1903-4 with two young Jersey heifers, not the same as those used in the previous year. The only difference between the two experiments was in period four. In this latter experiment instead of returning in period four to the conditions as in period one, the animals were given dried sugar beet pulp instead of wet sugar beet pulp, the dry matter and nutritive ratio being the same as in periods one and two. The object of this last experiment was to eliminate the possible effect of a variation in crude fiber. It will be noticed that by placing sugar beet pulp dry in the ration instead of sugar beet pulp wet, as in period two, we secure all of the conditions the same as in period two, with the exception of the factor of succulence. It is difficult to prove two unknown factors in an experiment and thus it was decided to eliminate one of them and confine the experiment entirely to the effect of succulence.

During the progress of the experiment daily analyses were made of the urine and feces of each animal and at the end of each period the results were averaged, giving the data for that particular period and feed. The urine of each animal was kept by itself in a large glass jar and a composite sample made daily at the same hour. Some difficulty was experienced in getting an average sample of the feces, until the happy idea suggested itself of using an earthen jar, adding water and mixing the contents with a hoe until it was thoroughly uniform. The samples duplicated nicely by this procedure, showing accuracy of mixing.

The results were measured in the laboratory by estimating the total nitrogen in the natural feces, dried feces, and in the feces after treatment to remove nitrogeneous products of metabolism. The determinations were, in all cases, made in duplicate and sometimes in triplicate. The natural feces or the wet samples were analyzed immediately after being brought to the laboratory in sealed glass jars. The dried feces were analyzed, after carefully drying in an electric oven below 70 deg. C. In no instance during the whole experiment did there fail to be an appreciable loss of nitrogen in drying. The nitrogen-products of metabolism were separated by the ether, alcohol, water and lime water method,[1] and the nitrogen determined in the residue, which was assumed to represent the undigested food.

FIRST EXPERIMENT, PERIOD ONE.

Feed given, 7.5 pounds oat straw, 2.5 pounds clover hay, 1 pound bran, 1 pound corn and cob meal.
Total dry matter, 10.65 pounds per day per cow.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Cow 2. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 65.2	60.4	32.6	28.2	24.5	39.9	(1) 65.5	60.8	32.6	28.7	22.2	39.2
(2) 32.1	29.6	27.0	21.6	18.3	17.4	(2) 65.5	60.8	35.5	26.8	24.3	30.5
(3) 65.2	60.4	18.6	15.4	13.5	46.4	(3) 65.5	60.8	32.3	28.7	26.1	34.5
(4) 32.0	29.6	21.6	19.4	16.5	36.8	(4) 65.5	60.8	29.4	35.2	30.4	33.3
(5) 65.2	60.4	27.2	24.7	21.0	32.1	(5) 65.5	60.8	27.2	20.8	18.5	37.3
(6) 32.1	29.6	23.2	19.6	16.6	26.5	(6) 65.5	60.8	30.4	24.0	19.9	30.2
(7) 65.2	60.4	23.6	20.1	16.4	24.2	(7) 65.5	60.8	30.6	23.9	20.7	32.3
(8) 65.2	60.4	28.2	24.2	20.7	31.7	(8) 65.5	60.8	33.5	30.5	26.8	32.0
Sum 422.2	391.2	202.2	173.5	147.6	255.1	524.0	487.0	251.8	218.8	189.2	269.4
Avg. 52.8	48.9	25.3	21.6	18.4	31.9	65.5	60.8	31.5	27.3	23.6	33.7

Cow 1.		Cow 2.	
Daily gain		Daily gain, grams	1.3
Daily loss, grams	4.4	Daily loss	
Digestibility of proteids on basis of N. in wet feces	48.2%	Digestibility of proteids on basis of N. in wet feces	48.2%
N. in dry feces	55.7%	N. in dry feces	55.1%
N. in treated feces	62.3%	N. in treated feces	61.1%

1. This method was conducted as follows:—1 gram of the dry, finely ground feces was treated with 25 cc. ether and boiled in an Erlenmeyer flask for ½ hour with a reflex condenser. The solution was then decanted on a 9 c. m. filter and the process repeated with a final washing by decantation until the feces gave no color to the ether. 50 cc., 95% alcohol is now poured upon the residue in the flask and boiled for 10 minutes as before. The supernatant fluid is now decanted upon the same filter as was used for the ether and the product washed with hot alcohol The sample is then treated on the steam bath for 20 minutes with 50 cc. water and the whole transferred to the same filter as before and washed thoroughly with hot water. Filter and feces are next transferred to a beaker with 50 cc. of a saturated solution of lime water and allowed to stand over night or for at least six hours. The whole is then transferred to a fresh filter and thoroughly washed with diluted lime water. The filter and contents are then dried and the nitrogen determined in the usual way.

FIRST EXPERIMENT. PERIOD TWO.

Feed given, 40 pounds wet beet pulp, 4.6 pounds oat straw, 1.6 pounds clover hay, .6 pounds bran, .6 pounds corn and cob meal.
Total dry matter, 10.62 pounds per day per cow.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1.						Cow 2.					
Food.	Proteids.	Wet. feces.	Dry feces.	Treated feces.	Urine.	Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 68.9	65.8	39.8	31.8	30.8	27.1	(1) 68.9	65.8	38.0	36.6	31.6	36.4
(2) 68.9	65.8	30.6	25.7	22.6	26.3	(2) 68.9	65.8	26.5	23.3	21.2	30.6
(3) 68.9	65.8	33.5	26.3	25.5	40.0	(3) 68.9	65.8	30.2	26.7	25.2	42.5
(4) 68.9	65.8	29.0	23.9	21.3	33.6	(4) 68.9	65.8	33.3	28.2	24.9	35.7
(5) 68.9	65.8	30.3	22.3	19.0	26.4	(5) 68.9	65.8	33.4	29.7	25.7	35.6
(6) 68.9	65.8	28.0	24.6	22.4	27.9	(6) 68.9	65.8	38.3	27.7	25.3	35.6
(7) 68.9	65.8	33.1	27.8	22.9	29.5	(7) 68.9	65.8	31.3	25.6	21.2	29.5
Sum 482.4	460.5	224.4	182.8	164.8	211.1	482.4	465.5	231.1	196.4	175.4	246.2
Avg. 68.9	65.8	32.0	26.1	23.5	30.1	68.9	65.8	33.0	28.0	25.0	35.1

Cow 1.		Cow 2.	
Daily gain, grams	6.8	Daily gain, grams	0.8
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	51.4%	Digestibility of proteids on basis of N. in wet feces	49.9%
N. in dry feces	60.4%	N. in dry feces	57.4%
N. in treated feces	64.2%	N. in treated feces	62.0%

FIRST EXPERIMENT, PERIOD THREE.

Feed given, 60 pounds wet beet pulp, 4.6 pounds oat straw, 1.6 pounds clover hay, .6 pounds bran, .6 pounds corn and cob meal.
Total dry matter 12.34 pounds per cow per day.
Nutritive ratio, 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1.						Cow. 2					
Food.	Proteids.	Wet. feces.	Dry feces.	Treated feces.	Urine.	Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 81.4	79.0	43.6	33.8	27.2	32.4	(1) 81.4	79.0	32.4	31.5	26.4	34.8
(2) 81.4	79.0	35.7	29.7	25.2	36.3	(2) 81.4	79.0	34.1	31.2	26.2	33.7
(3) 81.4	79.0	36.5	29.5	25.0	36.1	(3) 81.4	79.0	32.6	27.1	25.6	40.5
244.2	237.0	115.8	93.0	77.4	104.8	Sum 244.2	237.0	99.1	89.8	78.2	109.0
81.4	79.0	38.6	31.0	25.8	34.9	Avg. 81.4	79.0	33.0	29.9	26.1	36.3

Cow 1.		Cow 2.	
Daily gain, grams	7.9	Daily gain, grams	12.1
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	51.1%	Digestibility of proteids on basis of N. in wet feces	58.2%
N. in dry feces	60.8%	N. in dry feces	62.1%
N. in treated feces	67.3%	N. in treated feces	67.0%

FIRST EXPERIMENT, PERIOD FOUR.

Feed given, 7.5 pounds oat straw, 2.5 pounds clover hay, 1 pound bran, 1 pound corn and cob meal.
Total dry matter, 10.65 pounds per cow per day.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Cow 2. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 67.3	65.2	36.3	29.4	26.4	39.8	(1) 67.3	65.2	39.8	36.6	29.7	40.6
(2) 67.3	65.2	22.5	22.3	18.9	32.8	(2) 67.3	65.2	26.6	24.0	20.2	16.8
(3) 67.3	65.2	30.9	27.5	24.7	34.2	(3) 67.3	65.2	27.9	23.5	19.5	32.3
(4) 67.3	65.2	29.2	27.1	22.7	39.6	(4) 67.3	65.2	28.8	26.4	22.2	38.0
Sum 269.2	260.8	118.9	106.3	92.7	146.4	269.2	260.8	123.1	110.5	91.6	127.7
Avg. 67.3	65.2	29.7	26.6	23.2	36.6	67.3	65.2	30.8	27.6	22.9	31.9

Cow 1.		Cow 2.	
Daily gain, grams	1	Daily gain, grams	4.6
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	54.5%	Digestibility of proteids on basis of N. in wet feces	52.8%
N. in dry feces	59.3%	N. in dry feces	57.7%
N. in treated feces	64.5%	N. in treated feces	64.9%

SECOND EXPERIMENT, PERIOD ONE.

The cows used in the second experiment were smaller and consumed less food than those of the first experiment.
Feed given 6.3 pounds oat straw, 2 pounds clover hay, 0.8 pounds bran, 0.8 pounds corn and cob meal.
Total dry matter, 8.78 pounds per cow per day.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Cow 2. Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 50.3	45.0	21.5	20.5	16.0	25.7	(1) 49.7	44.5	21.9	20.5	15.5	15.3
(2) 50.4	45.0	26.0	22.3	18.9	16.6	(2) 49.7	44.4	24.5	24.4	18.3	19.7
(3) 50.1	44.8	28.7	26.6	20.6	21.5	(3) 50.4	45.0	25.2	21.4	16.0	21.2
(4) 50.2	44.8	26.1	18.6	15.0	23.7	(4) 50.5	45.2	25.9	22.1	17.8	21.7
(5) 49.4	44.6	25.6	24.1	19.5	18.3	(5) 50.6	45.2	27.8	24.0	18.1	22.1
(6) 50.5	45.2	35.9	28.5	23.8	21.1	(6) 50.4	45.0	24.0	23.1	17.2	22.3
(7) 50.2	44.8	25.4	27.2	21.5	18.9	(7) 50.8	45.4	21.1	20.0	15.2	19.9
Sum 351.7	310.4	189.2	168.1	134.6	145.8	352.1	314.7	170.4	155.7	118.4	142.2
Avg. 50.2	44.3	27.0	24.0	19.2	20.8	50.3	44.9	24.3	22.2	16.9	20.3

Cow 1.		Cow 2.	
Daily gain, grams	2.4	Daily gain, grams	5.7
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	39.1%	Digestibility of proteids on basis of N. in wet feces	45.9%
N. in dry feces	45.8%	N. in dry feces	50.4%
N. in treated feces	56.6%	N. in treated feces	62.3%

SECOND EXPERIMENT, PERIOD TWO.

Feed given, 33 pounds wet beet pulp, 3.8 pounds oat straw, 1.3 pounds clover hay, 0.5 pounds bran, 0.5 pounds corn and cob meal.
Total dry matter 8.71 pounds per cow per day.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1.						Cow. 2					
Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 48.7	43.8	29.0	26.1	21.5	21.2	(1) 39.5	35.5	25.4	*25.9	20.1	22.2
(2) 48.7	43.8	29.6	29.5	24.5	18.7	(2) 45.9	41.3	23.5	19.6	15.4	20.8
(3) 48.7	43.8	27.3	26.1	19.7	20.6	(3) 48.7	43.8	22.1	20.1	15.9	20.9
(4) 48.7	43.8	23.2	20.7	17.5	16.6	(4) 48.7	43.8	20.3	18.7	14.3	20.7
(5) 48.7	43.8	26.9	26.7	20.1	18.5	(5) 48.7	43.8	24.3	24.1	17.6	21.9
(6) 48.7	43.8	29.0	28.6	22.5	22.3	(6) 48.7	43.8	23.3	22.7	17.4	19.4
(7) 48.7	43.8	28.4	*28.9	24.0	17.5	(7) 48.7	43.8	20.6	20.2	15.2	23.3
Sum 340.9	306.6	193.4	186.8	150.0	135.3	328.9	295.8	159.5	151.6	116.1	149.2
Avg. 48.7	43.8	27.6	26.6	21.4	19.3	46.9	42.2	22.8	21.6	16.5	21.3

Cow 1.		Cow 2.	
Daily gain, grams	1.8	Daily gain, grams	2.8
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	37.0%	Digestibility of proteids on basis of N. in wet feces	46.0%
N. in dry feces	39.9%	N. in dry feces	48.9%
N. in treated feces	51.1%	N. in treated feces	60.7%

* Some slight error in sampling shows here. However there is in this experiment but a small amount of nitrogen lost on drying hence the slight error here is scarcely noticeable.

SECOND EXPERIMENT, PERIOD THREE.

Feed given, 50 pounds wet beet pulp, 3.8 pounds oat straw, 1.3 pounds clover hay, 0.5 pounds corn and cob meal.
Total dry matter 10.41 pounds per day per cow.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1.						Cow 2.					
Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 57.1	51.5	25.6	25.3	20.4	14.4	(1) 49.2	44.3	25.2	24.0	19.0	21.6
(2) 56.6	51.0	35.6	35.0	28.5	12.9	(2) 57.5	51.8	24.4	*24.5	19.5	17.9
(3) 56.6	51.0	34.6	34.1	28.0	15.1	(3) 52.9	47.6	25.9	25.3	18.5	19.4
(4) 57.2	51.5	29.8	*30.3	25.5	16.0	(4) 57.5	51.8	26.5	26.1	18.6	28.6
Sum 227.5	204.0	125.6	124.9	102.5	58.4	217.1	195.5	102.0	100.0	76.2	87.5
Avg. 56.9	51.0	31.4	31.2	25.6	14.6	54.3	48.9	25.5	25.0	19.0	21.9

Cow 1.		Cow 2.	
Daily gain, grams	10.9	Daily gain, grams	6.9
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	38.5%	Digestibility of proteids on basis of N. in wet feces	47.9%
N. in dry feces	38.9%	N. in dry feces	48.9%
N. in treated feces	49.8%	N. in treated feces	61.1%

* Slight error in sampling. Does not affect the results.

SECOND EXPERIMENT, PERIOD FOUR.

Feed given, 3.6 pounds dried beet pulp, 3.8 pounds oat straw, 1.3 pounds clover hay, 0.5 pounds bran, 0.5 pounds corn and cob meal.
Total dry matter 8.71 pounds per cow per day.
Nutritive ratio 1 to 12.2.

GRAMS OF NITROGEN IN

Cow 1.						Cow 2.					
Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.	Food.	Proteids.	Wet feces.	Dry feces.	Treated feces.	Urine.
(1) 54.1	46.9	33.0	32.5	25.3	16.2	(1) 56.0	48.5	29.3*	30.3	24.8	18.3
(2) 56.0	48.5	24.0	22.3	17.8	20.3	(2) 56.0	48.5	29.1	25.1	18.9	28.4
(3) 56.0	48.5	42.7	40.2	31.4	20.5	(3) 56.0	48.5	26.8	23.7	18.3	27.9
(4) 56.0	48.5	26.9	25.5	19.4	20.4	(4) 56.0	48.5	30.4	26.6	21.1	28.8
(5) 56.0	48.5	34.1	29.6	23.9	17.8	(5) 56.0	48.5	22.9	20.6	13.6	21.7
(6) 56.0	48.5	27.3	23.8	18.6	23.6	(6) 56.0	48.5	23.5	21.3	17.2	24.6
(7) 56.0	48.5	25.3	22.4	16.9	18.1	(7) 56.0	48.5	24.0	22.1	15.5	21.0
Sum 390.1	337.9	213.3	196.5	153.4	136.9	392.0	339.5	186.0	169.6	129.6	170.7
Avg. 55.7	48.2	30.4	28.1	21.9	19.5	56.0	48.5	26.1	24.2	18.5	24.4

Cow 1.		Cow 2.	
Daily gain, grams	5.8	Daily gain, grams	5
Daily loss		Daily loss	
Digestibility of proteids on basis of N. in wet feces	37.0%	Digestibility of proteids on basis of N. in wet feces	45.2%
N. in dry feces	41.7%	N. in dry feces	49.9%
N. in treated feces	54.6%	N. in treated feces	61.9%

* Not counted in the averages.

SUMMARY OF DIGESTIBILITY OF PROTEIDS ON THE BASIS OF NITROGEN IN THE WET FECES.

	First experiment.		Second experiment.	
	Cow 1.	Cow 2.	Cow 1.	Cow 2.
Period 1	48.2%	48.2%	39.1%	45.9%
Period 2	51.4%	49.9%	37.0%	46.0%
Period 3	58.2%	51.1%	38.5%	47.9%
*Period 4	54.5%	52.8%	37.0%	45.2%

*Period 4 in first experiment was of but four days duration and it is not considered to give very reliable data, but is inserted for what it is worth.

SUMMARY OF DIGESTIBILITY OF PROTEIDS ON BASIS OF NITROGEN IN DRY FECES.

	First experiment.		Second experiment.	
	Cow 1.	Cow 2.	Cow 1.	Cow 2.
Period 1	55.7%	55.1%	45.9%	50.5%
Period 2	60.4%	57.4%	39.9%	48.9%
Period 3	62.1%	60.8%	38.9%	48.9%
Period 4	59.3%	57.7%	41.7%	49.9%

SUMMARY OF DIGESTIBILITY OF PROTEIDS ON BASIS OF NITROGEN IN FECES AFTER REMOVAL OF NITROGEN PRODUCTS OF METABOLISM.

	First experiment.		Second experiment.	
	Cow 1.	Cow 2.	Cow 1.	Cow 2.
Period 1	62.3%	61.1%	56.6%	62.4%
Period 2	64.2%	62.0%	51.1%	60.7%
Period 3	67.0%	67.3%	49.8%	61.1%
Period 4	64.5%	64.9%	54.6%	61.9%

NITROGEN PRODUCTS OF METABOLISM IN THE FECES.

FIRST EXPERIMENT.

	Cow 1.	Cow 2.
	First period.	First period.
Wet feces	25.28 grams	31.35 grams
Dry feces	21.68 grams	27.35 grams
Loss on drying	3.60÷52.76= 6.8%	4.00÷65.57= 6.1%
Wet feces	25.28 grams	31.35 grams
Treated feces	18.46 grams	23.65 grams.
Total N. Products	6.82÷52.76=12.9%	7.70÷65.57=11.7%
	Second period.	Second period.
Wet feces	32.06 grams	33.01 grams
Dry feces	26.11 grams	28.05 grams
Loss on drying	5.95÷68.9 =8.6%	4.96÷68.9=7.2%
Wet feces	32.06 grams	33.01 grams
Treated feces.	23.54 grams	25.05 grams
Total N. products	8.52÷68.9=12.3%	7.96÷68.9=11.5%
	Third period.	Third period.
Wet feces	33.06 grams	38.60 grams
Dry feces	29.96 grams	31.02 grams
Loss on drying	3.10 ÷81.4 =3.8%	7.78÷81.4 =9.5%
Wet feces	33.06 grams	38.60 grams
Treated feces	26.06 grams.	25.84 grams
Total N. products	7.00÷81.4=8.6%	12.76÷81.4=15.7%
	Fourth period.	Fourth period.
Wet feces	29.74 grams	30.29 grams
Dry feces	26.59 grams	27.64 grams
Loss on drying	3.15÷65.3=4.8%	2.65÷65.3=4.1%
Wet feces	29.74 grams	30.29 grams
Treated feces	23.17 grams	22.94 grams
Total N. products	6.57÷65.3=10.1%	7.35÷65.3=11.3%

NITROGEN PRODUCTS OF METABOLISM IN THE FECES.

SECOND EXPERIMENT.

	Cow 1.	Cow 2.
	First period.	First period.
Wet feces	27.06 grams	24.37 grams
Dry feces	24.01 grams	22.24 grams
Loss on drying	3.05÷50.25=6.1%	2.13÷50.31=4.2%
Wet feces	27.06 grams	24.37 grams
Treated feces	19.22 grams	16.92 grams
Total N. products	7.84÷50.25=15.6%	7.45÷50.31=14.8%
	Second period.	Second period.
Wet feces	27.80 grams	22.81 grams
Dry feces	26.69 grams	21.66 grams
Loss on drying	1.11÷48.72=2.3%	1.15÷47.02=2.4%
Wet feces	27.80 grams	22.81 grams
Treated feces	21.43 grams	16.58 grams
Total N. products	6.37÷48.72=13.1%	6.23÷47.02=13.02%
	Third period.	Third period.
Wet feces	31.43 grams	25.53 grams
Dry feces	31.23 grams	25.01 grams
Loss on drying	0.20÷56.9=0.3%	0.52÷54.3=0.9%
Wet feces	31.43 grams	25.53 grams
Treated feces	25.61 grams	19.05 grams
Total N. products	5.82÷56.9=10.2%	6.48÷54.3=11.9 %
	Fourth period.	Fourth period
Wet feces	30.49 grams	26.60 grams
Dry feces	28.07 grams	24.26 grams
Loss on drying	2.42÷53.72=4.3%	2.34÷55.99=4.2%
Wet feces	30.49 grams	26.60 grams
Treated feces	21.92 grams	18.52 grams
Total N. products	8.57÷55.72=15.4%	8.08÷55.99=14.4%

SUMMARY OF THE NITROGEN PRODUCTS OF METABOLISM IN THE FECES.

First experiment.	Cow 1. %	Cow 2. %
First period.		
Loss on drying	6.8	6.1
Total metabolic nitrogen	12.9	11.7
Second period.		
Loss on drying	8.6	7.2
Total metabolic nitrogen	12.3	11.5
Third period.*		
Loss on drying	3.8	9.5
Total metabolic ntirogen	8.6	15.7
Fourth period.		
Loss on drying	4.8	4.1
Total metabolic nitrogen	10.1	11.3

Second experiment.*	Cow 1. %	Cow 2. %
First period.		
Loss on drying	6.1	4.2
Total metabolic nitrogen	15.6	14.8
Second period.		
Loss on drying	2.3	2.4
Total metabolic nitrogen	13.1	13.1
Third period.		
Loss on drying	0.3	0.9
Total metabolic nitrogen	10.2	11.9
Fourth period.		
Loss on drying	4.3	4.2
Total metabolic nitrogen	15.4	14.4

It is to be noted in this experiment that in period two with each animal there is a remarkable lowering of the percentage of both total and volatile nitrogen of metabolism on the introduction of wet beet pulp into the ration. This lowering continues in period three in spite of the fact that the animals were getting more dry matter while in period four in which the dry matter was the same as in periods one and two but dry beet pulp was substituted for wet pulp, the percentage of metabolic nitrogen is practically the same as in period one. This certainly indicates the influence of the succulent factor in the wet pulp.

The same results were indicated in the first experiment as to the total nitrogen and partially so as to volatile nitrogen with cow number one, but in this experiment the matter was not under such perfect control and the figures for volatile nitrogen are not of great value.

*In referring to balance table for period three, first experiment it is noticeable that while the nitrogen of the urine is nearly the same for both animals, the nitrogen in the feces is much greater for cow number two than for cow number one. This seems to indicate digestive disturbances of some nature and may account for the abnormal amount of nitrogen products of metabolism in this period.

DISCUSSION.

It is very noticeable that foods are utilized differently by different individuals. Two cows, although both are healthy and normal in every respect, will not utilize the same amount of nutrients in a given feed.

In the first experiment both cows showed a slight increase in digestibility when beet pulp wet was added to the ration. In the second experiment one cow gave a slight increase, while the other showed practically no change. These figures are, however, so slight when an average is taken that they cannot be said to prove an increase of digestibility due to the succulent feed.

In all of the experiments a consideration of digestibility based on the nitrogen as found in the feces before drying, shows that former figures of digestibility of succulent feeds are given at least 5 per cent too high. Different feeds show vary-

ing percentages of volatile nitrogen in the feces, and inasmuch as it appears with the undigested food it should be taken into consideration, else our co-efficients of digestibility are considerably too high. (See Penn, Report, page 272-273, year 1900-1901.)

REAL EFFECT OF SUCCULENCE.

Whatever the effect on the apparent digestibility of a food, which in these instances seems to be practically nil, it seems quite positive that a succulent food is digested at less expense than a dry food. In this way a succulent food should work antagonistic to a food rich in fiber and in the same capacity as grain. If an increase of cell oxidation is accompanied by an increase of metabolic nitrogen in the feces (Penn, Report, 1900-1901, p. 273, compare with Armsby, then surely the expenditure of energy on a food high in factors of succulence is less than on a dry food. The above being true, it follows that the net available energy, other factors being equal, is greater in a succulent feed than in a dry one.

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EXTENDED STUDIES OF THE ASSOCIATIVE ACTION OF BACTERIA IN THE SOURING OF MILK.*

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Two articles have already appeared upon this subject, published in the Cent. f. Bakt. II, Bd. XI, Nos. 24-25, and Bd. XII, Nos. 19-21. The investigations here presented are simply a continuation of the articles named with the purpose of furnishing a more intimate and extended acquaintance with this particular associative influence of bacteria upon the souring of milk. The studies will embody illustrative experimental data without any attempt to include all results, and will serve the writer's purpose in putting forth his summary without becoming too cumbersome; at the same time it will present the case in sufficient completeness for confirmation or further development, should either be undertaken. The material may be included and discussed under the following sub-topics:

I. A brief and pertinent historical consideration.
   a. General.
   b. Comments.
   c. Review of previous personal work.
II. The significance of different milks and their relation to germ development.
III. The changes produced in milk by germ B.†
IV. The possibilities of acid production in milk during the early stages of development of germ B.
V. The extent of this associative action in the souring of milk or the influence of other germs than germ B upon germ A.‡
VI. How the influencing of germ B upon germ A may be demonstrated in making butter.
VII. History of germ B.
VIII. Summary.

I a. GENERAL.

Many associative fermentations are familiar to bacteriologists,—on the one extreme one species is known to favor certain well defined changes by its influence upon another species, on the other extreme there are many instances in which decided antagonism is manifested by one species over another, thereby modifying fermentative results greatly. The extent of these associations with all degrees of possibilities cannot be determined in the present state of our knowledge; still there is much evidence which makes this phase of bacteriology not only important in its contributions to an advanced knowledge of the science, but, moreover, in its application to economic problems. Wherever life is found, whether in the form of plants or animals, there may be seen to exist the determining influence of some definite or indefinite association.

An exhaustive historical review would be out of place in this article because of its possible great extent and of the numerous diversions into other fields it would suggest, all of which would be interesting but not especially pertinent, and would produce a scattering of ideas where concentration is wished. It is more direct

*Included with these studies will be a somewhat prolonged consideration of milk variation in its relation to bacteriological conclusions.

†Germ B, the life history of which is given at the end of this article, is the bacterium which is known to exert a favorable influence upon the lactic bacterium studied. Throughout this paper, this micro-organism will be designated as germ B or culture B.

‡Germ A or culture A always refers to B. acidi lactici of Weigmann, Thierfelder, Esten, and others.

to recall a few fermentations similar to the one studied in the hope of correcting any false or dwarfed ideas the reader may gather in a very limited survey, as represented in this work, of a single section of a very broad territory.

The nature of vinegar fermentation has long been known. In it is found that peculiar dependence of the acetic micro-organisms upon the yeast cells or, in other language, the alcohol produced by the yeast cells* is essential to the proper development of the acetic germs which convert it into acetic acid in the manufacture of vinegar. This association is required to incite satisfactory fermentative results which we have learned to look upon as constant if suitable conditions are observed. By the work of Nencki† with the bacillus of symptomatic anthrax and micrococcus acidi paralactici was demonstrated that, by combination or association in culture, changes were wrought which could not be accounted for by the cultivation of either germ under isolated conditions and which could be measured by the formation of butyl alcohol over the products of each in separate culture. Burri and Stutzer‡ have shown that the colon micro-organism exerts a favorable action in the process of denitrification, causing the liberation of an abundance of free nitrogen from sodium nitrate when cultivated with Bacterium denitrificans I, but when each is cultivated in pure culture by itself, neither the colon nor denitrificans I is able to set free nitrogen as indicated in combination. The formation of nitrates from nitrites, and nitrites from ammonium salts through the co-operation of nitroso-and nitro-bacteria, following upon the degradation of nitrogenous organic matter by other classes of bacteria, confirms this interdependence of bacterial action, one species upon the other, and establishes the biological agent as causative and progressive, energètic and eminently capable of instituting many inter-and intra-molecular changes in nature. In the decomposition of meat there appears not a single biological factor, but several seem necessary to the destruction which passes from complex combinations of atoms through a series of steps to simple combinations. It is generally accepted that many of the pathogens frequently become more forceful§ in the production of their definite pathologic changes through the instrumentality of some non-pathogen, or some other pathogen; in other words, a mixed infection may give rise to a more drastic type of disease; that is, association of two species may greatly intensify the power of one to cause abnormal processes. So important and so practical is this that secondary infections are carefully guarded against, lest primary abnormalities become aggravated. In milk the kephir† granule has long been known as a combination of biological elements. Attempts to ascertain specific isolated individual action have been more or less futile. The koumiss starter is not confined to the functional capacity of a single micro-organism, but reaches into associative growth. Ginger-beer** is also recognized as the product of dual capacities, and believed the result of more than a single micro-organism. The antagonistic or associative influence of lactic bacteria over other bacteria is well known, but so far as the writer is cognizant, nothing has been done to demonstrate the favoring influence of some bacteria over the lactic germ. From this curtailed review, such relationship may be considered not as an impossibility; it has been our aim throughout these investigations to positively demonstrate this association and relationship and in this we have not been disappointed; also, we hope to further indicate several dependent, accompanying, and controlling circumstances.

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I b. COMMENTS.

Bacteriological workers with lactic bacteria have often met with inconsistencies in their lactic cultures which would not yield to satisfactory explanations and perhaps have felt many times that all factors and circumstances have not been brought to light. Lactic micro-organisms in pure cultures do not always behave the same, and they do not even when introduced into unsterilized milk. Whether the recognized irregularities may be attributable wholly to association the future must determine, but there will be manifest in these investigations other elements which should enter at least for consideration and may eventually become known influencing factors. Because of this possibility, considerable discussion and many data will follow, treating of some of the many forces at work.

Lactic micro-organisms grow slowly and irregularly in milk during the early stages of a culture and vary in cultures in which different milks have been employed. Whether this is due to the small number striving for foot-hold, or whether it is due to some inhibitive property of the milk, may be guessed partly from what is known of the germicidal action of fresh milk, of the enhanced value of partly digested milk for the cultivation of these germs, and of the great variability of milks in their response to bacteria. So pronounced are these factors at times that one is led to suspect that the nitrogen of milk may not be in the most suitable form for germ feeding, or the constituents of milk are not favorable to rapid development of germ life, or, perhaps, anti-bodies are present. These facts are established, however, as shall be seen later: All digestions are not able to furnish the products needed, for it will be found that a large percentage of milk peptonizing germs will prove worthless in fostering the souring of milk by favorably influencing lactic germs, on the other hand it is safe to anticipate a considerable influence exerted by the products of digestion upon the growth of lactic germs (a theme which will receive special attention) and upon the wholesomeness of milk (a subject we shall not discuss much in this paper) since the products are stable and will withstand heating; moreover, pasteurization and sterilization would not necessarily check in any way the action of these products if they are capable of inducing gastro-intestinal disturbances; the inhibitive or germicidal action of fresh milk is now fairly understood so far as its effects are seen, and while of no great practical meaning, it cannot be disregarded in these investigations; the marked influence different milks have upon the growth of germs is largely a matter of future determinations, still there is sufficient evidence offered in this article to regard it as a very important factor which is involved in nearly all milk studies.

I. C. REVIEW OF PREVIOUS PERSONAL WORK.

A cursory review of our own work which has already been published will be necessary to a comprehensive understanding of the entire field and the establishment of an existing continuity in the investigations.

It has been shown that germ B in association with germ A hastens the souring of milk over that produced by germ A in pure culture. This may be easily illustrated:

(a) By the naked eye appearance of the milk culture in which loppering occurred about ninety-six hours earlier in the combined culture A + B* than in a pure culture of germ A. In litmus milk the changes in the litmus may be followed more easily than the curdling, for the formation of acid is far more rapid in culture A + B, accordingly the litmus notes its production and progress.

(b) By studying the acidity of cultures A and A + B comparatively.

	Culture A.	Culture A + B.
0 hours after inoculation	18°	18°
24 hours after inoculation	18°	20°
44 hours after inoculation	28°	†64°
68 hours after inoculation	40°	74°
92 hours after inoculation	48°	84°
116 hours after inoculation	‡52°	93°
142 hours after inoculation	56°	108°

*Culture A + B represents a mixed culture in which are found germs A and B in equal amounts of twenty-four bouillon culture of each.

†Loppered. ‡Loppering.

This single test corresponds very favorably with the usual results obtained and is very representative. Milk for both cultures should be made from the same lot.

(c) By a comparative determination of the number of lactic bacteria in culture A and in culture A + B, at the time of the loppering of A + B and when germ B has completely disappeared. The ratio may be expressed as follows:

A : A + B : : 27 : 1614.

It has been also possible to demonstrate that germ B produces stable products which withstand sterilization and exert the same influence over germ A in milk cultures as the living germs themselves. Again this may be shown in a very similar manner as employed in the previous series:

*(a) By observing the milk cultures made from the same lot of milk and noting that culture (A + the products of B) loppers the milk as many as seventy-two hours earlier than culture A. With litmus milk it is possible to follow out the progress by the changes taking place in the litmus from the formation of acid.

(b) By a comparative study of acidity of culture A and culture (+ the products of B).

Flask-cultures.	0 hours old.	24 hours old.	46 hours old.	72 hours old.	96 hours old.
Same lot of milk:					
1 Germ A	22°	30°	48°	62°	66°
2 Germ A	22°	30°	46°	60°	66°
3 Germ A	22°	30°	48°	62°	64°
4 Germ A	22°	30°	48°	62°	66°
5 Germ A + products of germ B	26°	72°	108°	112°	112°
6 Germ A + products of germ B	26°	72°	106°	112°	110°
7 Germ A + products of germ B	26°	70°	108°	112°	110°
8 Germ A + products of germ B	26°	70°	108°	110°	110°

(c) By a comparative estimate of the number of germs in culture A and in culture (A + the products of germ B). The ratio may be expressed in the following manner:

A : (A + products of germ B) : : 27 : 1007.

Even at the present time there is no reason for altering these figures or results in the slightest degree. Repetition over the past year only confirms the conclusions reached in our previous article. However, in our work at that time there were evident some peculiarities which could not be satisfactorily explained; in the previous work, irregular results were obtained usually from the employment of different lots of milk in conducting a single test. For the time being this matter was allowed to rest and in the tests the same lot of milk was used and treated in precisely the same way.

II. THE SIGNIFICANCE OF DIFFERENT MILKS AND THE RELATION OF VARIABILITY TO GERM DEVELOPMENT.

Since it was so plainly indicated in the work with the products manufactured by germ B in milk after a few hours growth that the lactic germs responded favorably to their influence, it was suspected that ordinary milks contained germ products in greater or less quantities, some favorably influencing the growth of the lactic germs, others being indifferent, and still others antagonizing. These were considered a probable cause for the irregular results secured from somewhat varying or different milks. These products could be regarded as cleavage products resulting from the action of the germs upon the constituents of the milk, secretions of the germs, or a possible dissolution of the milk which is known to be very

*The products were secured by sterilizing forty-eight hour culture. See second article.

unstable, irrespective of germ life. Again, there was the possibility of finding that milks from different cows would respond differently to the influence of the same germ, even when sterilized within one hour after drawing. To arrive at some definite knowledge concerning these points, the writer began by testing milk as secured from the dairy and employed in the laboratory.

In testing milk, as it is obtained from the dairy, for cultural purposes, it has been noted in this laboratory that when subjected to heating at

20° it sometimes loppers and sometimes does not,
21° it sometimes loppers and sometimes does not,
22° it sometimes loppers and sometimes does not.

Of course 22° milk is far more likely to lopper than 20° milk, but in this instance it is not the *customary action* which should be considered, but the *uncustomary*, for it is the deviation from normal conditions sought.

Bacteriologists have been aware of discrepancies occurring in milk culture work for some time, and have been somewhat at a loss to discover the cause for this. The behavior of certain species in milk could not always be confirmed, and error is the usual charge in a case of failure in confirmation. When irregularities do occur or are found it were better to look for the specific reasons than to turn it off as unfathomable and personal. The author does not wish to express or draw any positive conclusions from his work on the variations of milk, but finds it essential to his studies with association; accordingly, he is compelled to give the results of experiments conducted up to this time.

Three lots of milk were secured from the dairy at different times and were labeled as *fresh*, *fresh dairy*, and *old dairy milk*. The *fresh* was obtained from the stable, separated and sterilized within one hour after coming from the cow. The *fresh dairy* milk had been skimmed in the dairy and is what would be regarded as ordinary sweet dairy milk. The *old dairy* milk had been skimmed and stood in the dairy some time and had taken an upward start in acidity. These different lots were flasked, using an equal amount for each flask, and sterilized by the discontinuous method. After sterilization, into each flask was placed one c. cm. of a 1: 1000000 dilution of a bouillon culture of germ B. These high dilutions of cultures have been found throughout our work as necessary to satisfactory measurement. When these milk cultures had stood for a time, a portion was tested by heating to determine whether it would curd or not, and at what point of time such curding would take place with the different lots of milk. This was instigated by the experience with germ B which was learned to produce curding in some milks in the cold but always by heating, at some stage. The following table will give the results:

Original milk designated as—	Original acidity.	Temperature maintained C.	Time of loppering by heating.	Acidity at time of loppering.
Fresh (stable)	19°	21°	50 hours	19°
Fresh (dairy)	20°	21°	47 hours	20°
Old (dairy)	21°	21°	42 hours	21°

Two explanations for these differences are possible; the one, that germ B produces a certain amount of acid which in addition to that already present is sufficient to lopper the milk, earlier in the more acid milk when subject to heat, and later in the less acid; the other, there is formed an enzyme of products which in the presence of the acid of the more acid milk, manifests itself sooner when heat is applied. We assume in this case that the enzyme acts before sufficient heat has been applied to destroy it. Some space will be given later to the discussion of the possibility of an increased acidity in the development of germ B; consequently, it is unnecessary to enter into the question at this point other than to say that evidence in its favor appears meager. A very old culture of germ B, strongly alkaline, will throw down an abundant precipitate upon heating, and in most milks, cultures of germ B have to be well under way before curding will take place by the application of heat. If there is any ques-

tion of increased acidity, it must be considered during the very early hours of the culture, for soon the alkalinity increases. The formation of a lab enzyme in sufficient quantities after several hours to curdle the milk seems more probable, yet even this explanation is by no means final, for this hypothesis and the facts do not coincide as fully as they ought. The cultures in milk show considerable advancement in digestion before loppering takes place. It is true that lab enzymes not infrequently form in the presence of peptic digestion, but are unable to manifest themselves on account of the rapid dissolution of the milk. To this it may be said that in some milk cultures curding takes place slightly but perceptibly before much digestion has taken place, while in other milks there is no evidence of curding. In the heating of the cultures, too, the rapid rise of temperature would possibly destroy the enzyme. Of course there is a chance of enzymic action before the temperature becomes too high, yet so far as we can determine, the precipitation does not occur with the warming, but rather with the prolonged heating. To further eludicate this matter in hand, boiled sweet milk can be made to curdle in much the same manner as the flask cultures by the addition of some of a digested milk culture of B of long standing, which has been boiled and filtered. *This simple test confirms what has been suspected: The products, stable and not enzymic in nature, are able to produce a precipitation.* This has been demonstrated with cultures neutral in reaction to litmus and also decidedly alkaline to the same indicator. Neither acids nor enzymes but products of another nature apparently cause the curding upon heating. Perhaps we may later be able to show that different milks respond differently to the development of germ life because such products are formed more easily in some milks than others. The differences, therefore, manifested in the above table may be said to be due to the differences in the amount of products manufactured by germ B in the different lots of milk, and further, the measure of the products would also measure the germ development which seemingly has some relation to the character or condition of the milk in which they are grown.

Another effort to ascertain the variability of different milks, employing germ A, will add to the evidence. In this instance, the time of curding and the measured acidity will serve as the key to the situation.

Lot of milk (dairy milk.)	One.	Two.	Three.	Four.	Five.
Original acidity	15°	14°	16°	16°	14°
Number of germs introduced per c cm	692	692	692	692	692
Time of testing acidity of culture	120 hrs.	120 hrs.	120 hrs.	120 hrs.	120 hrs.
Acidity of culture	34°	23°	24°	37°	27°
Time of natural curding	148 hrs.	384 hrs.	264 hrs.	148 hrs.	275 hrs.
Temperature maintained, C.	20°	20°	20°	20°	20°

The lots of milk employed in this test were secured from the dairy on different days, were inoculated with the same number of germs, were manipulated in the same manner, were maintained at the same temperature, and all the conditions were identical with the exception of the different lots of milk. The results, as indicated by the time of curding and the degree of acidity, are indeed irregular. In the employment of the same lot of milk, a constancy and uniformity are very striking whenever the manipulative processes have been carefully executed. When beginning this work on association, this irregularity growing out of the employment of different lots of milk caused much confusion; fortune favored by requiring the same lot of milk in each test as well as absolute uniformity in sterilizing and all other operations in its preparation. It is absolutely necessary to observe accuracy and uniform manipulation, otherwise the operator is likely to fail in associative studies. This may be illustrated by the use of a single lot of milk subjected to uniform treatment for studying cultural results.

Lot (dairy milk.)	One.	Two.	Three.	Four.
Number of germs introduced per c. cm	249	249	249	249
Time of testing acidity	72 hrs.	72 hrs.	72 hrs.	72 hrs.
Acidity	62°	60°	62°	62°
Time of curding	55 hrs.	55 hrs.	55 hrs.	55 hrs.
Temperature maintained	23°	23°	23°	23°
Count of germs per 1-1000000 c. cm	112	113	111	112

The flask cultures moved along together in their development without any appreciable difference in appearance. They were as one flask.

Comparing such uniform results as obtained in the table just outlined with what has gone before and with what will follow as additional evidence, it follows that care must be exercised if constant interpretations are sought, and if dependence is to be placed upon milk cultural work from the bacteriological standpoint. Generally mixed milks are employed and these are more likely to be uniform than milk from individual cows.

Richmond* gives a table of analyses of milk from different breeds:

Breed.	Total solids.	Fat.	Milk sugar.	Proteids.	Ash.
Ayrshire	12.70	3.68	4.84	3.48	.69
Guernsey	14.48	5.02	4.80	3.92	.75
Holstein	12.12	3.51	4.69	3.28	.64
Jersey	14.34	4.78	4.85	3.96	.75
Shorthorn	12.45	3.65	4.80	3.27	.73

He also illustrates the variation in milk from the same cow in another table.†

	p. m. 9/6/87	p. m. 10/6/87	p. m. 11/7/87	a. m. 12/7/87	p. m. 13/7/87	a. m. 14/7/87	p. m. 11/11/88	a. m. 12/11/88.
Total solids	14.0	12.8	14.3	16.7	11.0	14.8	15.1	12.1
Fat	4.9	3.8	9.4	10.5	4.9	8.2	6.3	3.2
Milk sugar	....	....	....	....	1.91	3.26	....	....
Proteids	....	....	....	....	3.35	3.32	....	....
Ash	....	....	.78	.76	.86	.76	....	....
Solids not fat	9.1	9.0	4.9	6.2	6.1	6.6	8.8	8.9

Little attention is usually paid to the acidity of milk, [1], [2], [3], [4], although it has long been known that it is subject to great variation, because of its more or less indefiniteness; but in our bacteriological work it is possible that it plays an important rôle as possessing functions of its own or standing for a measurement of milk constituents, consequently some tests of our own determinations are added to illustrate recorded knowledge which is not usually free of access.

*Richmond's "Dairy Chemistry," p. 125.
†Richmond's "Dairy Chemistry," p. 124.
1. See the work of P. Dornic, Revue Generale du Lait, 1 re, Annee No. 10, p. 217.
2. Note:—Milk is alkaline or amphoteric to litmus and acid to phenol-phthalein. Hoppe-Seyler—Thierfelder. Physiologisch and Pathologisch-Chemische Analyse (1903), S. 537.
3. "Milk has always, when fresh, an amphoteric reaction: i. e., it turns blue litmus paper slightly red and turmeric paper slightly brown. A similar reaction is possessed by certain phosphate solutions, and it is probably to the presence of such in milk that this reaction is due. Much has been written on this subject, but it is a point which more properly belongs to the chemistry of litmus and turmeric than to the chemistry of milk. This reaction has required a false importance owing to the erroneous idea that neutrality as measured by the action of litmus is chemical neutrality; with the recognition of the fallacy of this idea, the importance of the amphoteric reaction vanishes." Richmond—Dairy Chemistry (1899), p. 8.
4. K. Storch, in "Tierarztliches Zentralblatt" Wien, 32, 1904, also "Revue Generale du Lait," 4e, Annee, No. 6, says that the chemical reaction of milk is independent of food and that it is produced by the presence of acid and neutral phosphates which do not neutralize each other. Only when the acids of fermentation are produced, the neutral salts are transformed into acid salts and the reaction of the milk becomes acid. The milk is amphoteric when the relation of the acid and neutral salts is satisfactory, otherwise it is alkaline or acid.

	5/22	5/23
Red Polled (Pansy Belle)	9°	....
Grade 31	18°	16°
Holstein (College Houwtje)	5°	11°
Swiss (College Becky)	13°	15°
Holstein (College Belle)	14°	6°
Grade 11	17°	18°
Grade 17	18°	....
Grade 32	....	19°
Holstein (College Houwtje Mae)	....	14°

From these tables it is safe to draw the conclusion that milk from different animals varies widely, as also does milk from the same animal.

Some notion may be gained from the mixing of milk which, too, is subject to marked variation, but within more limited ranges. Richmond gives a table on page 127 (loc. cit.) in which he states a mean monthly average of milk for the past sixteen years. This does not illustrate accurately the composition of mixed milk, but rather the greatest possible uniformity.

Month.	Specific gravity.	Total solids.	Fat.	Solids not fat.
January	1.0322	12.88	4.02	8.86
February	1.0322	12.78	3.93	8.85
March	1.0322	12.71	3.88	8.83
April	1.0322	12.66	3.84	8.82
May	1.0323	12.66	3.82	8.84
June	1.0322	12.59	3.79	8.80
July	1.0317	12.66	3.93	8.73
August	1.0316	12.73	4.02	8.71
September	1.0319	12.92	4.12	8.80
October	1.0322	13.13	4.21	8.92
November	1.0322	13.19	4.30	8.89
December	1.0322	13.04	4.16	8.88

Mixed milk as we get it from the dairy usually is confined to a range of 14°-20° acid with phenol-phthalein as indicator, and may most commonly be found about 18° acid. This is the general understanding among dairymen, hygienists, and physiologists, and is not contrary to accepted belief. However, it has not been sufficiently considered from the standpoint of the bacteriologists in its relation to his work.

It is now our purpose to add further confirmation and interesting bacteriological data to what has already been given. An instance of a mixed culture of germs A + B will contribute to the same line of thought.

Milk lot (dairy milk.)	One.	Two.	Three.	Four.	Five.
Original acidity	19°	18°	12°	17°	13°
Number of germs introduced per c. cm—					
Germ A	766	766	766	766	766
Germ B	1,520	1,520	1,520	1,520	1,520
Time of testing acidity	96 hrs.	96 hrs.	96 hrs.	96 hrs.	96 hrs.
Acidity	33°	23°	57°	57°	62°
Time of curding	130 hrs.	336 hrs	96 hrs.	144 hrs.	96 hrs
Temperature maintained C.	20°	20°	20°	20°	20°

Irregular results are not very noticeable in this table, but there appears to be a discrepancy between the acidity and the time of curding. This discrepancy will probably be found one of the features of milk variation either due to the composition of the milk or products arising from germ activity or perhaps katalytic processes.

Several tables which will now follow vary somewhat in the milk employed and the germ planted.

GERM A USED FOR ALL.

Milk lot (dairy milk.)	One.	Two.	Three.	Four.	Five.	Six.
Original acidity	15°	14°	16°	15°	16°	14°
Number of germs introduced per c. cm	35	35	35	35	35	35
Time of testing acidity	72 hrs.	72 hrs.	72 hrs.	72 hrs.	72 hrs.	72 hrs.
Acidity	29°	27°	40°	43°	31°	34°
Time of curding	165 hrs.	160 hrs.	145 hrs.	140 hrs.	165 hrs.	160 hrs
Temperature maintained C	20°	20°	20°	20°	20°	20°
Count per 1-1000000 c. cm	20	24	25	25	20	22

GERM EMPLOYED—GERM B.

Milk lot (dairy milk.)	One.	Two.	Three.	Four.	Five.	Six.
Original acidity	15°	14°	16°	15°	16°	14°
Number of germs introduced per c. cm	85	85	85	85	85	85
Time of testing acidity	90 hrs.	90 hrs.	90 hrs.	90 hrs.	90 hrs.	90 hrs.
Acidity	19°	19°	19°	18°	17°	17°
Temperature maintained	20°	20°	20°	20°	20°	20°
Colonies per 1-1000000 c. cm. milk culture	....	150	1	100	75	....

In the next table is given a test in which the milk employed has been sterilized within an hour after coming from the cow.

TWO LOTS RUN AT DIFFERENT TIMES.
GERM USED—GERM A.

Milk lot (fresh from cow.)	Holstein One.	Swiss Two.	Holstein One.	Swiss Two.
Original acidity	14°	12°	13°	10°
Number of germs introduced per c. cm	235	235	130	130
Time of testing acidity	72 hrs.	72 hrs.	80 hrs.	80 hrs.
Acidity—Two flasks	44° 44°	40° 40°	41° 40°	36° 35°
Temperature maintained C	20°	20°	20°	20°

In this table irregularities may be traced to individual cows.

If any conclusion is to be drawn from the evidence presented, and we must be very cautious in drawing a conclusion of any kind, it may be found in the well known fact that milk from different cows and from the same cow at different times varies widely and that this variation is capable of making itself manifest upon the development of micro-organisms, sometimes favoring, sometimes retarding, but at all times of sufficient importance to bear in mind when milk is used for cultural purposes.

My work extends sufficiently far to say that litmus added to milk causes irregularities in cultures, not among the litmus milk cultures themselves, but when compared with the same lot of milk, as plain milk cultures. This has been very noticeable in our work, but as yet the work is too limited for prolonged discussion with contributing experimental facts. This subject of milk variation is not as well defined or as satisfactory as one would wish, but it has entered so largely into the work with association that to leave it out would fail of proper inference, and confirmation would become more difficult.

While we are compelled to admit that milk is subject to great variability traceable to the cow herself, yet we should not lose sight of the probability of products forming in milk as secondary products of germ action, giving rise to favorable or unfavorable influence upon primary fermentation as illustrated in our associative studies. It may be that these products at times are stable and toxic and existing in sufficient quantities to produce gastro-intestinal

disturbances. While the variation in the first instance may be regarded as physiological and normal, in the second instance it may be regarded as bacterial and abnormal.

It has long been known that rennet in the making of cheese acts more readily upon milk which has ripened for some time than upon wholly fresh milk. So commonly recognized is this that chesse makers employ more rennet in the curding of sweet milk than where a certain amount of acid has developed. Mr. H. C. Oven working in this laboratory, with the action of pepsin and rennet on milk, has contributed some data which confirms the chemical and bacteriological experiences given in the foregoing paragraphs.

PEPSIN THAT IS EMPLOYED FOR CHEESE MAKING.

Breed of cow.	Time of testing.		
	9:30 a. m.	10:45 a. m.	3:00 p. m.
Ayrshire	10½ min.	13¼ min.	12¾ min.
Brown Swiss	4 min.	5 min.	4¾ min.
Holstein 1	39½ min.	54 min.	No curding in 1½ hrs.
Holstein 2	No curding in 1 hr.	No curding in 1 hr.	No curding in 1 hr.

*The time in minutes represents the time required for curding. No curding in a definite time means that it was allowed to stand for the time stated without effect and observation was discontinued. The amount of pepsin employed was at the rate of 20 grams to 1000 lbs. of milk. The temperature maintained was 30° C.

Another test was made with rennet, such as is employed commonly by cheese makers throughout the State.

RENNET.

Breed of cow.	Time of testing.			
	9:00 a. m.	10:00 a. m.	11:00 a. m.	2:00 p. m.
Grade 1	14¼ min.	20½ min.	29½ min.	17½ min.
Grade 2	19¾ min.	38½ min.	40¾ min.	23¾ min.
Grade 3	13½ min.	21 min.	31¼ min.	19 min.
Grade 4	12½ min.	23 min.	34¾ min.	20½ min.

The time throughout the table is indicated in minutes. The amount of rennet used was at the rate of 4 oz. per 1000 lbs. of milk. The temperature maintained was 30° C.

*Here again, by the use of enzymes, it is possible to show a marked difference in the response of milk from different cows. It has been our experience throughout that the grade animals give a more uniform milk and that the Holstein shows the lowest acidity, and is slowest to respond to rennet. The Holstein produces the lowest amount of solids, also. It would necessitate far more extensive tests to make the differences manifested by breeds of tenable significance for each breed. We mention this possibility without drawing conclusions so far as breeds are concerned. Our primary purpose is to establish the value of different milks or perhaps the inconstancy of milks in their relation to bacteriological conclusions. Chemically, this irregularity is recognized, but in bacteriology it has been disregarded too much.

* The action of rennet may be dependent upon the acidity of the milk, the acidity upon the dibasic and neutral phosphates, and perhaps citrates present, consequently rennet action returns to the mineral constituents of milk, one of which probably figuring more largely than others is lime.

III. THE CHANGES PRODUCED IN MILK BY GERM B.

It has been demonstrated fully that some product or products manufactured by germ B, while growing in milk are responsible for the favorable influence upon germ A; it has also been shown that these products are thoroughly stable when subjected to discontinuous sterilization, and, further, when these products after complete sterilization are added to sweet milk, curding may be produced.

To determine what these products are is a difficult task, and we are still in the dark concerning them, yet by studying this subject from the synthetic and analytic standpoints, a little knowledge, at least, is gained.

Suspecting that through the rapid digestion of milk by germ B there might be digestion products corresponding to other products already known upon the market, an effort was made to furnish such a product by simple addition to milk, bouillon and agar. These preparations used did not prove a success and none even approached an agar, made from the actual products of germ B, placed in milk for the cultivation of germ A. Improvement in the growth of germ A was obtained by the addition of certain substances it is true, but all fell so far short of what really occurs in the presence of germ B or its products that little attention was given them.

The changes produced by germ B, visible to the naked eye, may be noted from time to time. At first there is a yellowish, watery layer seen upon the surface of the milk, a complete digestion of the casein. This process continues downward until the entire milk is practically peptonized. The proteolytic capacity of the germ is marked by rapid progress under the most favorable conditions. As the culture ages the pigment changes to orange yellow and the consistency of milk is slimy. The culture is turbid and alkaline. The odor, which is very strong, is perceptible as soon as the germ starts. At first it is cheesy, passing to pineapple, and then, in old cultures, to a putrid character. These visible changes in culture and the pronounced change in odor would indicate a continuous change in products during the process of degradation of the proteid substances of milk.

To arrive at a suggestive knowledge of the changes wrought by germ B in milk, analyses of cultures at different ages were undertaken after the usual methods. It is of course understood that while our knowledge of the proteid constituents of milk and their degradation is so incomplete and also of the methods employed for estimation so unsatisfactory, the results secured should be regarded as indicative rather than absolute.

I.

	Percentage of Nitrogen.	
	Control flask sterile.	Culture flask germ B, 48 hours old.
Total nitrogen	.5474	.525
Casein	.4536	.2912
Albumin	.0224	.0182
Caseoses, peptones, etc	.0252	.0674
Amido compounds	.0238	.0032
Ammonia	.0224	.035

II.

	Control flask sterile.	Culture six weeks old.
Total nitrogen	.4598	.4638
Casein	.3766	.0434
Albumin	.0252	.0000
Caseoses, peptones, etc	.021	.0840
Amido compounds	.021	.2107
Ammonia	.016	.1757

These analyses assist in understanding what is going on during the development of a culture of germ B in milk, and they also tell us that perhaps the hydrolised products, amido bodies, or ammonia compounds may be the cause of the hastened growth of the lactic germs. The fact that early in the development of germ B, the lactic germs are stimulated, may mean that the caseoses are more instrumental than the others; still from the beginning amido and ammonia compounds are apparently produced in traces. It is impossible to draw any definite conclusions from these analyses; only in a most general way do they help to associate lactic development and proteolysis in this specific case. In some other instances proteolysis does not seem to be able to accomplish this favorable action on lactic germs.

IV. THE POSSIBILITY OF ACID PRODUCTION IN MILK DURING THE EARLY STAGES OF DEVELOPMENT OF GERM B.

This is a very important question to raise in connection with the associative results of germ A and B, as it may be suspected at once that a small amount of acid produced by germ B added to the acid known to be produced by germ A may account for the associative result, and also a very slight increase of acidity may hasten the work of any lab enzyme which may be present. In the latter case the acidity of the mixed culture must be regarded as apparent and not real, and the increase indicated would have to be accounted for by the action of germ B on the indicator which may be regarded as a feasible explanation.

As cultures of germ B age, they become more and more alkaline. This cannot be gainsaid for it is very apparent by the use of litmus as an indicator. With phenol-phthalein as indicator, an increased acidity would be noted, but this is probably due to the destructive action of the germs upon this indicator. When germ B is grown in litmus milk the blue of the litmus changes to a dirty, reddish blue, then it completely disappears, but after the greatest activity of the germs subsides, distinctly blue patches reappear upon the immediate surface of a flask culture. It can be seen from this that if the changing of blue litmus to a reddish blue and the apparent increase of acidity by means of phenol-phthalein is in reality due to acid formation then the matter is settled at once, but the litmus becomes more decidedly blue as the culture in milk ages, if added in sufficient quantity at the time of testing; and the phenol-phthalein indicator, when this strong alkalinity is so pronounced with added litmus, marks a higher acidity. There is this, too; litmus or phenol-phthalein allowed to stand in the old culture a very short time is destroyed and will manifest no response. Other indicators employed give no better results. What then may be concluded under such circumstances? It is our purpose to bring together a few observations to enable us to form a satisfactory understanding.

In order to obviate the difficulties experienced in the use of milk culture for the determination of acid formation and to furnish a clear, transparent medium, saccharine bouillon cultures were utilized to study reaction changes. Bouillon of the same lot was divided into several portions, to each of which was added one of the following sugars: Saccharose, dextrose, lactose, levulose. Inoculation of each was made at the same time with the same number of germs. A soluble starch bouillon was also added to the list. So far as could be observed, the reaction began to change in the direction indicated in the table until the tenth day, when the results were recorded.

	Check acidity.	Acidity of culture after ten days.
Saccharose bouillon	15°	6°
Dextrose bouillon	15°	10°
Lactose bouillon	15°	8°
Levulose bouillon	15°	14°
Starch bouillon	15°	15°

In starch there is evidently no reduction in acidity but in the other cases, with the exception of levulose, it is quite apparent. The starch had undergone change

into dextrins* but had not produced any reducing sugars.† There was no gas formation in any of the cultures. These facts help to confirm the view that no acid is formed at any time during the development of the culture. In the chemical analyses of cultures of germ B there is every evidence to believe that no formation of acid occurs because of the constantly increasing amounts of amido and ammonia compounds occurring right on the start. The forty-eight hour culture showing reddish blue litmus, is represented in our analyses, and these results would assist greatly in clearing this field. It is also significant to note the character of the germs which besides germ B are capable of yielding about the same influence upon the lactic germ A. By summing up, the entire field is presented in a few words:

1. Litmus during the first few hours is changed to a muddy, reddish blue, then completely reduced.
2. Phenol-phthalein is in some manner affected by the products of germ B in milk culture, and partly destroyed.
3. Other indicators tested have no higher value in this work than litmus and phenol-phthalein.
4. Old milk cultures of germ B are decidely alkaline.
5. In saccharine bouillon cultures there is an increased alkalinity, with the exception of levulose.
6. Starch is changed to dextrins, but no reducing sugar is formed. Reaction is not altered.
7. In milk-cultures by analysis, increasing amounts of amido and ammonia compounds are produced.
8. Other known germs of the same character are capable of causing practically the same action, varying in degree of intensity, and no acid constituent has been recognized among their products.
9. The curding effect this germ sometimes possesses has now been traced to its products, which are decidedly alkaline, especially in old cultures. This was the strongest argument for a long time in favor of acid production, but is not tenable after showing the products will curd milk.

The author has felt constrained to present the matter of acid formation very fully because unless the reader has it clearly in mind, there is a possibility of being misled. The one strong factor which would not allow the author to reach a very definite conclusion in regard to all milks early in these investigations was the occasional curding of milk by germ B before complete peptonization. After demonstrating that the products apart from acid or enzymes could do this, no further trouble existed in believing that there is no acid formation on the start followed by alkali production, but that the alkaline reaction increases steadily from the beginning and continues for some time.

V. THE EXTENT OF ASSOCIATIVE ACTION IN THE SOURING OF MILK OR THE INFLUENCE OF OTHER GERMS THAN GERM B UPON GERM A.

This phase of the subject might be carried on indefinitely, if worked out in detail. The writer has been so fully occupied with germs A and B that he has not been able to get far beyond, still he has made an attempt to extend the studies to other associations, in all of which germ A figures as the lactic germ, but some other micro-organism has been substituted for germ B. Mr. F. B. Howard has assisted with germs 12100 and Proteus vulgaris.

GERM 12100 AND GERM A.

Culture.	A.	12100 + A.
Age of culture	72 hrs.	72 hrs.
Temperature maintained	23° C.	23° C.
Acidity	65°	80°
Character of culture	*	†
Count of micro-organisms	704,000,000 per c. cm.	916,000,000 per c. cm.

*Smooth, thick lopper. †Loppered and whey separated.

*Iodine was used as ordinarily for this determination.

†Fehling's Solution was employed.

PROTEUS VULGARIS AND GERM A.

Culture.	A.	Proteus + A.
Age of culture	48 hrs.	48 hrs.
Temperature	22° C.	22° C.
Acidity	44°	59°
Character of culture	*	†
Count of micro-organisms	540,000,000	1,000,000,000

*Curd soft—no separation of whey. †Hard curd—whey separated.

MYCOIDES AND GERM A.

Culture.	Mycoides.	Mycoides + A.	A.
Acidity	20°	62°	20°
Time	48 hrs.	48 hrs.	48 hrs.
Temperature	21°	21°	21°

PRODIGIOSUS AND GERM A.

Culture.	Prodigiosus.	Prodigiosus + A.	A.
Acidity	25°	40°	30°
Time	48 hrs.	48 hrs.	48 hrs.
Temperature	21°	21°	21°

GERM 999 AND GERM A.

Culture.	999.	999 + A.	A.
Age of cultures	24 hrs.	24 hrs.	24 hrs.
Temperature maintained	23° C.	23° C.	23° C.
Acidity	30°	92°	42°
Time	48 hrs.	48 hrs.	48 hrs.
Character of culture	*	†	‡

*Litmus blue; no lopper. †Litmus pink; loppered. ‡Litmus pink; no lopper.

GERM X AND GERM A.

Culture.	X.	X + A.	A.
Temperature maintained	23°	23°	23°
Acidity	42°	62°	48°
Time	72 hrs.	72 hrs.	72 hrs.
Character of culture	*	†	‡

*Litmus reduced; partly loppered. †Litmus reduced; loppered. ‡Litmus pink; loppering.

GERM 1077 AND GERM A.

Culture.	1077.	1077 + A.	A.
Temperature maintained	23°	23°	23°
Acidity	20°	60°	56°
Time	72 hrs.	72 hrs.	72 hrs.
Character	*	†	‡

*Litmus blue; no lopper. †Litmus reduced; loppered. ‡Litmus pink; loppered.

GERM 1055 AND GERM A.

Culture.	1055.	1055 + A.	A.
Temperature maintained	23°	23°	23°
Acidity	40°	64°	64°
Time	96 hrs.	96 hrs.	96 hrs.
Character	*	†	‡

*Litmus blue; unchanged. †Litmus pink; soft lopper. ‡Litmus pink; soft lopper.

GERM 1028 AND GERM A.

Culture.	1028.	1028 + A.	A.
Temperature maintained	23°	23°	23°
Acidity	13°	67°	67°
Time	120 hrs.	120 hrs.	120 hrs.
Character	*	†	‡

*Litmus blue; unchanged. †Litmus reduced; soft lopper not so thick as A. ‡Litmus pink; soft lopper.

GERM 1016 AND GERM A.

Culture.	1016.	1016 + A.	A.
Temperature maintained	23°	23°	23°
Acidity	13°	65°	66°
Time	120 hrs.	120 hrs.	120 hrs.
Character	*	†	‡

*Litmus blue; unchanged. †Litmus reduced; lopper not so advanced as A. ‡Litmus pink; soft lopper.

VI. HOW THE INFLUENCE OF GERM B UPON GERM A MAY BE DEMONSTRATED IN BUTTER.

Mr. W. R. Wright carried on some experiments in which he attempted to demonstrate the influence of germ B in the making of butter and its possible control by the use of germ A.

Cream lot.	Division of lot.	Amount of B. added.	Amount of A. added.	Condition of butter.
I	1	5%	2½%	Very strong of B.
	2	5	5	Very strong of B.
II	1	....	5	Tainted.
	2	5	5	Very strong of B.
III	1	....	8	Very good.
	2	5	8	Quite strong of B.
IV	1	....	15	Very good.
	2	5	15	B easily detected.
V	1	....	20	Excellent.
	2	5	20	B easily detected.
VI	1	....	25	Excellent.
	2	5	25	Strong; B easily detected.
VII	1	....	30	Excellent.
	2	5	30	B easily detected.
VIII	1	....	35	Excellent.
	2	5	35	B easily detected.
IX	1	....	40	Excellent.
	2	5	40	B easily detected.
X	1	....	40	Excellent.
	2	5	40	B easily detected.
XI	1	....	40	Excellent.
	2	5	40	B easily detected.
XII	1	....	45	Excellent.
	2	5	45	B practically disappeared.

So well defined were the flavor and odor of germ B that even with the use of a 45 per cent starter of germ A a mere trace of germ B could still be recognized. In our experience germ B could scarcely be detected by isolation after the acidity of the culture reached fifty degrees. This work has considerable practical significance in the use of starters and has some value scientifically in showing the persistency of germ B.

VII. HISTORY OF GERM B.*

Source—Micro-organism isolated from the college dairy milk, and is more or less constantly present.

Form and Grouping—Bacillus. It has a short rod with bluntly rounded ends. There is a tendency to form short threads, yet it may be found single and in pairs as often as in threads. It is very difficult to recognize the divisions marking the individuals.

Size—Length 1.75—5.25 microns. Diameter .58—.875 microns. The maximum length may be subject to much variation, owing to close union of bacilli in threads. The cultures used for measurement were selected because of the great freedom from thread formation.

Protoplasm—A marked homogeneity of the protoplasm exists with meta-chromatic granules irregularly distributed.

Pigment—An orange yellow pigment forms with the full development of the culture and in the presence of oxygen. The growth at first is a yellowish white, gradually shading into orange yellow as further development takes place.

Spores—No spore formation has been detected.

Flagella—No flagella have been demonstrated.

Motion—No motion is visible.

Staining—Readily stained with the common aniline stains. No special staining methods have been found applicable.

Temperature—Grows most vigorously at 30°—35° C. Its range is wide, 15°—39° C. It is killed at 60° C. for 5 min.

Colony—Colonies on gelatin plates start as small white dots, with microscopically fringed borders which become more and more regular and better defined as the colony matures. The colony rises from the surface, at first in a yellowish white, creamy, semi-spherical mass, and little by little, as time passes, turns to a deep orange color, becomes very flat, and the border is sharp. There is little if any liquefaction of gelatin unless the moisture content of the plate is maintained to enable uncurbed development. There is frequently found, in planting this germ, a bunching effect which interferes greatly with satisfactory counts.

Stab Culture (gelatin)—Growth spreads quickly over surface of gelatin. Liquefaction takes place in funnel-shaped manner as soon as growth covers surface. With liquefaction the growth appears as a thick scum on the surface of the base of the funnel or cone, with little sediment at apex of the funnel. The remaining liquefied gelatin remains clear with minute pieces of tenacious particles or zoöglea scattered through it. The funnel gradually works its way towards the bottom of the tube, but several days are required at 20° C.

Bouillon Culture—At first culture appears homogeneously cloudy; following this, germs become adherent to glass at the surface, but no scum forms. There is also a decided orange yellow sediment with the clearing of the supernatant fluid.

Agar Cultures—The growth begins as a yellowish white or creamy raised semi-spherical mass, with no great inclination to spread much from point or line of inoculation. The color of pigment develops into deep orange, often passing through a lemon yellow from the creamy stage. In stab agar the growth takes place very slightly below surface but is very abundant over it. The germ does not appear sensitive regarding agar conditions for it develops readily upon the varying agars used for laboratory purposes, as well as upon whey agar, giving a luxuriant development upon each.

Potato Culture—About the first evidences of growth will be found in a light, shiny, moist, yellow mark appearing along line of inoculation. The creamy aspect so constant in agar and gelatin is easily overlooked, for it has been in

*Prof. H. W. Conn has worked out the history of this germ independently, and it will appear in his forthcoming treatise on "Dairy Bacteria."

the investigator's experience scarcely observable. As the culture ages, the deep orange yellow appears as is the custom with other media.

Milk Culture—The first noticeable change in milk is a very thin yellowish layer of digested milk. This occurs rapidly at 20° C. if the milk is inoculated with large amounts of culture, and even with minute quantities rapid changes may be instituted. The peptonization of milk advances from the surface downward, causing so far as can be determined at the start, no alteration of the acidity, but, as the culture ages, there is a very decided falling off in acidity to phenol-phthalein, with a corresponding increase of alkalinity. Not infrequently a perceptible curding of the milk at the bottom of the flask or tube has been found and for some time it was thought that it was due to contamination. With careful manipulation, the conclusion has been reached that the curding seems a property of some milks though perhaps some products already formed, in other milks through some inherent characteristic or in still others through a possible contamination. The author has secured this curding in milks, sterilized within an hour from the cow, in fresh dairy milk, in old dairy milk, and always in milk cultures upon heating,—the age of the culture being the determinative factor. As the milk culture ages, a slimy condition manifests itself and remains permanent thereafter. The odor produced in milk begins with that of cheese, passes into that of the pine-apple, and from this to one which touches on putrefaction. The orange yellow pigment is very pronounced in old milk cultures. For a more extended consideration of milk cultures, a study of the body of this article should be made.

Oxygen Requirements—It falls little short of being an obligate aerobe. Hydrogen greatly retards development.

Saccharose Bouillon—Acidity reduced from 15° to 6° in 10 days at 20°.

Glucose Bouillon—Acidity reduced from 15° to 10° in 10 days at 20°.

Lactose Bouillon—Acidity reduced from 15° to 8° in 10 days at 20°.

Levulose Bouillon—Acidity reduced from 15° to 14° in 10 days at 20°.

Starch (soluble) Bouillon—Acidity unchanged. Starch reduced to some form of dextrin. No reducing sugar formed.

Reaction—Production of alkaline substances in nitrogen degradation from proteid substances. Amido and ammonia compounds found in cultures.

Gas Production—No gas of any sort ever discovered.

Indol Reaction—Slightly perceptible in 48 hours.

SUMMARY.

1. Associative or mixed cultures become significant through the development of two or more micro-organisms together in a single series of microbial changes.
2. Associative or mixed natural cultures are not uncommon and have been known for many years in connection with various well known fermentations and disease processes.
3. Studies in which it has been shown that lactic bacteria have been favorably influenced in their growth by other bacteria are not known to the investigator.
4. Lactic bacteria are favorably influenced in their development by the presence of certain other bacteria.
5. Indications make this possible influence quite extensive.
6. Products manufactured by these bacteria in milk are known to exert the same influence as the living bacteria.
7. These products are stable through prolonged sterilization.
8. It is necessary, in order to demonstrate this associative action satisfactorily, to note the responses of variable milks from different cows to germ growth, otherwise irregular results will be obtained.
9. The products of germ B in its growth upon milk suggest many possibilities but no conclusions may be drawn.
10. The influence exerted in germ B in the making of butter and the amount of starter necessary to bury it, indicates the importance of associative influence in practical dairying. This same influence doubtless extends to cheese. Further, when it is recalled that the products of the germ are stable, it is easily seen how pasteurization or sterilization at times become ineffective in the preparation of milk for consumption or infant feeding and how easily toxic products

may pass through unchanged. At present, however, no one can say how far reaching associative action is or to what practical end it makes its way, but this much is clear: It emphasizes the necessity for pure milk, as to its freedom from bacteria, and as to its proper management.

I wish to add in closing that experiments are now under way to extend this work in its practical bearing and if possible to secure a more intimate knowledge of its nature.

I feel grateful to Prof. H. W. Conn for reviewing the manuscript of this article.

MICHIGAN

STATE AGRICULTURAL SOCIETY

MICHIGAN STATE AGRICULTURAL SOCIETY.

REPORT OF THE TRANSACTIONS OF THE SOCIETY FOR THE YEAR 1904 AND PROCEEDINGS OF THE WINTER MEETING, AND OTHER MEETINGS OF THE EXECUTIVE COMMITTEE PREVIOUS TO JUNE 30, 1905.

OFFICERS FOR 1904.

President—E. HOWLAND, Pontiac.
Vice President—STEPHEN BALDWIN, Detroit.
Treasurer—C. W. YOUNG, Paw Paw.
Secretary—I. H. BUTTERFIELD, Pontiac.

EXECUTIVE COMMITTEE.

Term ending January, 1905.

Eugene Fifield	Bay City, Bay County.
L. W. Barnes	Byron, Shiawassee County.
W. P. Custard	Mendon, St. Joseph County.
E. N. Ball	Hamburg, Livingston County.
W. E. Boyden	West Bay City, Bay County.
M. L. Dean	Agricultural College, Ingham County.
J. E. Rice	Grand Rapids, Kent County.
C. A. Waldron	Tecumseh, Lenawee County.
John McKay	Romeo, Macomb County.
John A. Hoffman	Kalamazoo, Kalamazoo County.

Term ending January, 1906.

E. W. Hardy	Howell, Livingston, County.
Frank Maynard	Jackson, Jackson County.
H. R. Dewey	Grand Blanc, Genesee County.
H. H. Hinds	Stanton, Montcalm County.
F. E. Skeels	Harrietta, Wexford County.
F. G. Jacobs	Pontiac, Oakland County.
W. W. Collier	Detroit, Wayne County.
Byron E. Hall	Port Huron, St. Clair County.
John Marshall	Cass City, Tuscola County.
Geo. H. German	Franklin, Oakland County.

EX-PRESIDENTS.

Members Ex-Officio.

T. W. Palmer	Detroit, Wayne County.
M. P. Anderson	Midland, Midland County.
John T. Rich	Elba, Lapeer County, P. O. Detroit.
I. H. Butterfield	Pontiac, Oakland County.

STANDING COMMITTEES AND EXECUTIVE SUPERINTENDENTS.

BUSINESS.

Eugene Fifield, John A. Hoffman, I. H. Butterfield.

TRANSPORTATION.

F. G. Jacobs, H. H. Hinds, E. W. Hardy.

PROGRAM.

H. H. Hinds, Geo. H. German, Secretary.

PRINTING AND ADVERTISING.

The Business Committee.

FINANCE.

John McKay, H. R. Dewey, M. P. Anderson.

PREMIUM LIST.

C. W. Young, I. H. Butterfield, J. A. Hoffman, C. A. Waldron, John McKay, J. E. Rice, W. E. Boyden.

RULES.

F. E. Skeels, W. P. Custard, L. W. Barnes.

RECEPTION.

M. P. Anderson, Stephen Baldwin, W. W. Collier.

EXECUTIVE SUPERINTENDENTS.

General Superintendent—Eugene Fifield.
Chief Marshal—H. H. Hinds.
Cattle—W. E. Boyden.
Horses (other than speed)—C. A. Waldron.
Horses (speed)—Eugene Fifield.
Sheep—H. R. Dewey.
Swine—L. W. Barnes.
Poultry—Daniel Thomas, Pontiac.
Farm and Garden Products—E. W. Hardy.
Dairy, Bees and Honey—John Marshall.
Vehicles—J. E. Rice.
Agricultural Implements and Machinery—John A. Hoffman.
Main Building, Manufactures and Miscellaneous—F. E. Skeels.
Art—Byron E. Hall.
Needlework and Children's Work—Mrs. F. E. Skeels, Harrietta.
School Exhibits—Frank Maynard.
Horticulture—M. L. Dean.
Gates—W. P. Custard.
Police—E. N. Ball.
Forage—Geo. H. German.
Concessions and Privileges—F. G. Jacobs.
Transportation—F. G. Jacobs.

CAUCUS AND ELECTION, 1904.

A meeting of the society called by the executive committee was held at the office of the president on Wednesday September 14, at 10 o'clock a. m.

Called to order by president.

On motion, M. P. Anderson was elected chairman and I. H. Butterfield secretary.

On motion, adjourned to the Grange tent on the grounds. H. C. Ward and F. B. Giddings were appointed tellers to admit to the tent only those who hold memberships. On motion of D. L. Davis it was decided to vote by the uplifted hand when not voting by acclamation. The following nominations were made:

For President—Eugene Fifield, of Bay City.

For Vice President—Stephen Baldwin, of Detroit.

For Treasurer—C. W. Young, of Paw Paw.

For Secretary—Ira H. Butterfield, of Pontiac.

For First Member of Executive Committee—Wm. Dawson, of Sanilac Center.

For Second Member of Executive Committee—A. E. Stevenson, of Port Huron, and L. W. Barnes, of Byron, were named. A vote by uplifted hands resulted in favor of Mr. Stevenson, who was declared nominated.

For Third Member of Executive Committee—W. P. Custard, of Mendon.

For Fourth Member of Executive Committee—George B. Winans, and E. N. Ball, both of Hamburg, were named. A vote by uplifted hands resulted in favor of Mr. Winans, who was declared nominated.

For Fifth Member of Executive Committee—W. E. Boyden, of West Bay City.

For Sixth Member of Executive Committee—George Kelley, of North Branch.

For Seventh Member of Executive Committee—J. E. Rice, of Grand Rapids.

For Eighth Member of Executive Committee—Lawrence W. Snell, of Highland Park, and C. A. Waldron, of Tecumseh, were named. A vote by uplifted hands resulted in favor of Mr. Snell, who was declared nominated.

For Ninth Member of Executive Committee—John McKay, of Romeo.

For Tenth Member of Executive Committee—John A. Hoffman, of Kalamazoo.

The caucus then adjourned.

The annual election of officers of the Michigan State Agricultural Society was held on the fair grounds at Pontiac, Thursday, September 15, 1904.

M. O. Rowland, one of the judges chosen, not being present, John W. Snow, of Birmingham, was appointed in his place.

The judges being duly sworn, proceeded with the election.

The polls were open from 9 o'clock a. m., until 5 o'clock p. m., resulting in the election of all the candidates placed in nomination, upward of 600 ballots being cast, which were counted by the inspectors with the president, the result being declared by President Howland.

THE FAIR OF 1904.

The annual fair of 1904 was one of the largest exhibits ever held by the society. As shown by the reports, there were over 600 cattle, 1,000 sheep and 600 swine, and over 1,400 entries of poultry, with all other departments full. The attendance was good and the gross receipts above the average.

MINUTES OF MEETINGS OF EXECUTIVE COMMITTEE DURING WEEK OF FAIR.

Meeting of the executive committee at Hodges House, Monday evening, September 12, 1904.

Present—President, Vice President, Treasurer, Secretary, Messrs. Fifield, Barnes, Custard, Ball Boyden, Rice, Anderson, Waldron, Hoffman, Hardy, Maynard, Dewey, Hall, Marshall, German.

Reading of minutes of last meeting dispensed with.

Reports of superintendents—general superintendent—superintendent speed recommended that a class for 2:15 pace be made for Thursday, 15th, provided five entries and four start.

Carried.

On motion of Hon. J. W. Cochrane, of Midland, R. V. Mundy, of Bay city, and M. O. Rowland, of Paw Paw, were appointed judges of election.

It was moved that the election be held in the election booth on the grounds.

It was moved by Mr. Fifield that the caucus be held at the president's office on the grounds at 10 o'clock Wednesday, September 14th.

On motion, adjourned to meet Tuesday evening at 7:30 o'clock, standard time.

Meeting of the executive committee, Tuesday, September 13, 1904, at Hodges House, Pontiac, at 7:30 p. m., standard time.

Present—The President, Treasurer, Secretary, Messrs. Fifield, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Anderson, Barnes, German.

Minutes of last meeting read and approved.

It was moved that the order be suspended and reports from any superintendent be received.

Carried.

Superintendent cattle, reported all stock cared for.

Mr. Hoffman moved that automobiles with one seat be admitted at 25 cents and those with two or more seats at 50 cents and that all be treated the same as vehicles with horses attached in relation to police regulation on the grounds.

Mr. Barnes moved that as an amendment that all automobiles be charged 50 cents each. Amendment carried. Motion as amended was adopted 10 ayes to 3 nays.

On motion, adjourned to meet Wednesday evening at 7:30 at Room C., Hodges House, Pontiac.

Executive committee met as per adjournment at Hodges House, Pontiac, Wednesday evening, September 14, 1904.

Present—President Howland, Baldwin, Young, Secretary, Fifield, Barnes, Custard, Ball, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Marshall, Anderson.

Minutes of last meeting read and approved.

On motion order of business was suspended and superintendent's reports were called for.

A protest was received signed by John Lessiters Sons, J. T. Smith & Sons, J. Frantz and Wollcott & Plumb, relating to ages of cattle awarded premiums in Class 10.

On motion of Mr. Fifield the superintendent was directed to procure evidence relating to the ages of said cattle and present to the executive committee Thursday evening.

Motion carried.

A protest was received from Peter Carten relating to premium in Class 20, Lot 195, on account of unsoundness.

The superintendent reported that the horse objected to had been examined and pronounced sound.

It was moved that the protest be not sustained.

The general superintendent requested the superintendents of cattle and horses to arrange for a cavalcade of live stock on Friday.

Adjourned to meet at 7:30 p. m., Thursday, 15th, Hodges House.

Executive committee met at Hodges House, Pontiac, Thursday evening September 15th, at 7:30 p. m.

Present—The Treasurer, Secretary, Messrs. Barnes, Custard, Ball, Dean, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Hall, Marshall, Anderson.

In the absence of the president Mr. John McKay was called to the chair.

Minutes of last meeting read and approved.

Mr. Maynard moved that when this committee adjourn it be adjourned to meet in Detroit on Tuesday, September 27th, at 9 o'clock a. m. at such place as may be secured by the secretary.

Carried.

On motion of Mr. Hoffman a recess was taken to Friday evening at 7:30 p. m., standard time.

Carried.

Executive committee met at Hodges House Pontiac, Friday evening, September 16th, at 7:30 p. m., a recess having been taken from Thursday evening.

Present—The President, Treasurer, Secretary, Messrs. Fifield, Barnes

Custard, Boyden, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Ball, Skeels, Jacobs, Hall, Marshall, German, Anderson, Dean.

The president claimed that the proceedings of Thursday were irregular.

On motion the committee proceeded with the regular order of business.

Mr. Fifield moved that the reports of superinendents be received.

Carried.

Superintendent Speed—Reported successful races.

Mr. Fifield moved that in view of the efficient services of Mr. John Thompson, the marshal, that he be presented with $10 in addition to his regular pay as an appreciation of his services.

Carried.

Superintendent Cattle—Presented statement of Dr. J. W. Brodie, V. S., as follows:

"I hereby on examination find two steers shown by G. W. Harness as two-year-olds with full mouths, also two steers shown as yearlings with four large teeth up.

(Signed) J. W. BRODIE, V. S."

The superintendent stated that while the cattle showed teeth indicating greater age than that for which they are entered, it was not improbable that they might be eligible. Mr. Young moved that the matter be left with the superintendent of that department to dispose of.

Pending the consideration of this subject, Mr. L. W. Cochrane was heard regarding the award of third premium in Class 19. Premium being withheld by superintendent on account of being unsound.

Mr. Cochrane declared the horse sound and presented Dr. J. W. Brodie in testimony as to soundness. Superintendent Waldron contended that the horse is not sound.

Mr. Fifield moved that the report of the superintendent be sustained.

Carried.

Mr. Boyden moved that the society pay the veterinarian for his services.

Motion lost.

Superintendent Horses—No report.

Superintendent Sheep—Verbal report, save notice that he would make some recommendations at winter meeting.

Superintendent Swine—Reported work completed.

Superintendent Poultry—Reported work completed.

Superintendent Farms—Reported best exhibit in years.

Superintendent Dairy—Good exhibit.

Superintendent Farm Machinery—Good exhibit.

Superintendent Main Building—Best ever.

Superintendent Art—Good exhibit.

Superintendent Needlework—Full exhibit.

Superintendent School Work—Large exhibit.

Superintendent Horticultural—Good exhibit.

Superintendent Gates—Good.

Superintendent Police—Good order.

Superintendent Forage—O. K.

Superintendent Concessions—No friction.

A protest was received from Adams & Perry relating to the award in lot 190, carriage horses 16 hands, on the ground that the pair awarded first prize were not 16 hands.

It was moved that the protest be referred to the superintendent with power to act.

Carried.

Mr. Maynard moved that when the committee adjourn, it be adjourned to meet in Detroit on September 27th, at 9 o'clock a. m., at such place as the president and secretary may engage.

Mr. Fifield moved as a substitute that the president be requested to call a meeting of the executive committee to meet in Detroit at 9 o'clock a. m., September 27th.

Substitute carried.

It was moved that the place of meeting at Detroit be left with the president and secretary.

Carried.

Mr. Maynard moved that all after the reading of the minutes of the proceedings of the meeting on Thursday be striken from the record.

Carried.

Adjourned.

Meeting of the executive committee at Normandie Hotel, Detroit, September 27th, at 9 o'clock a. m.

Present—President Howland, Vice President Baldwin, Treasurer Young, Secretary Butterfield, Fifield, Barnes, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Hardy, Dewey, Skeels, Collier, Hall, Marshall, German, Anderson.

Minutes of last meeting read and approved.

Superintendent of Horses reported protest in lot 190 was sustained by him.

Mr. Boyden reported that he had asked for affidavit in case of protest in Class 10 and would report to secretary later.

President stated that the meeting was for the purpose of considering the site question.

Mr. Baldwin stated that the Detroit Citizens' Committee were ready with automobiles, to show sites.

Mr. Hall moved that the hospitality of the citizens committee be accepted.

A recess was taken to 2 o'clock p. m.

2 o'clock p. m.

Committee met, same members present, and Mr. Jacobs.

Mr. Anderson moved that the vote locating at Detroit be reconsidered. The motion was lost on a division 8 to 9.

Mr. Jacobs appealed from the ruling, and asked for roll call. Vote, 11 ayes, 11 nays, motion lost.

Mr. Young moved that the committee accept the site known as the 7½ mile site on Woodward Avenue, provided that the conditions promised in the proposals made at Battle Creek, are fulfilled.

Mr. Fifield, Mr. Baldwin, Mr. Collier.

It was moved as a substitute by Mr. Collier, that the Detroit Citizens' Committee be invited to meet with this committee for conference.

Substitute carried.

Mr. Jacobs moved that the vote at the meeting of May 6th, accepting the Medbury site be rescinded.

Mr. Young made the point of order, that the motion is not in order.

The president decided the motion to be in order.

The ayes and nays were called for, with the following result:

Ayes—Howland, Fifield, Boyden, McKay, Hardy, Skeels, Jacobs, Marshall, German, Anderson, Ball—11.

Nays—Baldwin, Butterfield, Young, Barnes, Custard, Rice, Waldron, Hoffman, Dewey, Collier, Hall—11.

Mr. Young moved that the site known as the 7½ mile site offered by the Detroit Citizens' Committee be accepted as the site for the permanent location of the annual fairs of this society subject to the conditions made by this committee and as submitted to this committee by the citizens' committee of Detroit, by written proposition. That possession be given in thirty days from this date, and deed be given in ninety days, and that the sum of $35,000 in addition be paid to the society within six months from date.

A ballot was ordered, F. E. Skeels and B. E. Hall tellers. Whole number votes cast, 22. Yes, 13. No, 8. Blank, 1.

The president declared the motion carried.

Mr. Anderson moved that the committee adjourn to meet in this city thirty days from date, at a place to be designated by the president and secretary.

Motion carried.

Adjourned.

Meeting of the executive committee, Michigan State Agricultural Society, at Normandie Hotel, Detroit, October 27th, at 9 o'clock a. m., as per adjournment of September 27th, notice given.

In the absence of the president the vice president called the committee to order.

Roll called, the following members present: Messrs. Baldwin, Young, Butterfield, Barnes, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Hinds, Skeels, Collier, Hall, Marshall, Anderson, Rich.

Quorum present.

Minutes of the last meeting read and approved.

The vice president presiding stated the object of this meeting to perfect the arrangements with the Detroit Citizens' Committee regarding the site selected at the last meeting for permanent location of the fair. Pending the arrival of the Detroit committee, the question of purchase of the Michigan State Building at St. Louis was informally discussed.

Mr. Hardy moved that the matter be referred to a committee, Mr. Hinds, Mr. Young and Mr. Hoffman. And that the committee be authorized to offer $1,250 for this building if in their judgment it is advisable to do so.

The motion was carried on division. Ayes, 10; nays, 3.

Mr. Boyden moved to reconsider the motion of Mr. Hardy for reference of purchase of the Michigan building to committee.

Carried.

The motion was then laid on the table.

Mr. J. L. Hudson, chairman of the finance committee, of the Detroit Citizens' Committee presented a contract for land of site selected for permanent location of the state fair, together with abstracts of title and also agreements for laying pipes for water to grounds and facili-

ties for electric lighting and also for the payment of $35,000 in cash to the society.

The contract was read, and on motion was referred, together with the abstracts and agreements to the business committee and Mr. Young with instructions to examine and report.

On motion, Mr. Anderson and Mr. Rich were added to the committee to examine contract and agreements.

The committee were instructed to report today.

A recess was taken to 1:30 p. m.

One-thirty p. m., Executive committee met. Same members present.

The committee to examine the contract, abstracts and agreements reported as follows:

To the Executive Committee:

Gentlemen: Your committee to whom was referred the contracts and agreements submitted by the citizens' committee of Detroit for conveyance of the site for permanent location of the state fair, has examined the papers submitted, together with abstracts of title to lands, and find them satisfactory and in accordance with the proposition submitted by the Detroit Citizens' Committee, and by resolution of this committee at a meeting held September 27, 1904; and we recommend that the contract be accepted for the conveyance of these lands as a permanent location for the annual fairs of the Michigan State Agricultural Society, and that this contract and the agreements for water mains and electric light facilities be placed in the hands of the Secretary for safe keeping.

Signed JOHN A. HOFFMAN,
I. H. BUTTERFIELD,
C. W. YOUNG,
JOHN T. RICH,
M. P. ANDERSON.

Mr. Hoffman moved that the report be accepted and adopted, and that the roll be called on the adoption of the report. The report was adopted, on roll call of members, as follows: Yeas—Messrs. Baldwin, Young, Butterfield, Barnes, Custard, Ball, Boyden, Rice, Waldron, McKay, Hoffman, Hardy, Maynard, Dewey, Hinds, Skeels, Collier, Hall, Marshall, Anderson, Rich—Yeas 21. Nays, none.

A motion by Mr. Hardy to refer the question of purchasing the Michigan State Building at St. Louis to a committee composed of Mr. Hinds, Mr. Young and Mr. Hoffman, and that the committee be authorized to offer $1,250 for the building, if in their judgment, it is advisable to do so, was adopted by the following vote: Yeas, 10; nays, 3.

The committee to whom was referred the purchase of the Michigan State Building reported as follows:

To the Executive Committee:

Gentlemen—Your committee to whom was referred the matter of investigating the status of the Michigan State Building upon the World's Fair grounds and the advisability of making a proposition to buy the same, beg leave to report that they have had the matter under careful consideration, having had a long conference with Mr. Smith, president of the Michigan World's Fair Commission; have looked over the photographs of the building and its interior and gather this fact: If we

proceed to act immediately, offering $1,250 for the building, taking it as it now stands, we will effect its purchase. We also estimate that less than $1,000 will wreck the building and restore the site, placing the material upon the cars for shipment. We are not advised as to amount it will cost to transport same from St. Louis to Detroit. In fact, we have not sufficient figures before us to make an estimate of that item of cost. We are of the opinion that an amount not to exceed $2,000 would restore the building upon the State Fair grounds, providing same was on track within the grounds. In view of the fact that the only indefinite item before us is that of transportation, that we are unable to make a report upon, we beg leave to report that we recommend its purchase by the State Agricultural Society as above indicated.

We also suggest that very prompt action be taken as the secretary of the committee at St. Louis must be advised of our action by 3 o'clock this afternoon.

Respectfully submitted,
Signed H. H. HINDS,
C. W. YOUNG,
JOHN A. HOFFMAN,
Committee

On motion, the report was accepted and adopted.

Mr. Skeels moved that the business committee be authorized to complete the purchase of the Michigan building.

Carried.

Mr. Skeels moved that it is the sense of this committee that the business committee begin preparations on the new site for improvement and holding the fair of 1905.

Carried.

Mr. Collier moved that the committee on preparation of plans of grounds and buildings which was appointed on May 6, 1904, be authorized to visit St. Louis as well as other state fair grounds they may think desirable and inspect the buildings on the Louisiana Purchase Exposition grounds and that the business committee authorized to purchase buildings or material which they may deem useful and valuable to this society in the erection of buildings on the site selected for permanent location.

Motion carried.

Mr. Hinds moved that at the close of this session of this committee a recess be taken to meet at the call of the committee on plans of grounds and buildings, if that committee shall deem such meeting necessary before the annual winter meeting of the executive committee.

Motion carried.

Mr. Anderson moved that if any member on plans of grounds and buildings is unable to go with the committee on the visit to other state fair grounds and St. Louis that the committee have authority to invite some other member of the executive committee to accompany them and act as a member of the committee for the visit.

Carried.

A recess was taken to meet at call of committee on plans of buildings and grounds as per motion of Mr. Hinds previously adopted.

I. H. BUTTERFIELD, Secretary.

Adjourned.

Mr. Fifield being unable to make the trip with the committee on plans for grounds and buildings, Mr. M. P. Anderson was invited to go with the committee as member thereof as per authorization of the executive committee.

WINTER MEETING OF THE EXECUTIVE COMMITTEE.

The executive committee met at the Hodges House, Pontiac, Monday evening, January 9, 1905, at 8 o'clock p. m.

Called to order by the president. Roll called. Present—The President, Vice President, Treasurer, Secretary and members of the executive committee, Messrs. Fifield, Barnes, Custard, Ball, Boyden, Rice, Marshall, Hardy, Dewey, McKay, Hall, Skeels, Jacobs, German, Hoffman. Quorum present.

Minutes of meeting of October 27th read.

On motion of Mr. Custard the minutes were approved and adopted. Mr. Jacobs objecting to the approval on the ground that the meeting was not regularly called.

President Howland presented no formal address.

The secretary reported moneys received by him during the year as follows:

American Shorthorn Breeders' Association	$297 00
Stall, pen and poultry fees collected	519 50
Memberships sold	587 00
Special tickets sold	46 05
Advertising collected, 1903	105 00
Advertising collected, 1904	1,221 00
Rebate on tickets	3 41
Michigan Shorthorn Breeders' Association	131 00
	$2,909 96

A detailed statement is presented herewith.

Also entries and amounts awarded in the several divisions and classes.

The report of the business committee was also presented showing the business transactions of the year in detail.

REPORT OF TREASURER.

The treasurer presented his report as follows:

To the Members of the Executive Committee of the Michigan State Agricultural Society:

Gentlemen—I herewith present my report as treasurer of the society for the year 1904.

RECEIPTS.

General admissions	$15,350 85	
Grand stand	3,164 25	
Privileges	3,882 00	
State appropriation	5,000 00	
Secretary	2,909 96	
Speed Department	3,100 00	
Railroad coupon admissions	7,673 00	
Memberships sold	547 00	
Balance on date last report	19,414 13	
		$61,041 19

DISBURSEMENTS.

Paid in business orders	$29,375 87	
Paid in premium orders	14,660 09	
		44,035 96
January 9, 1905, balance on hand		$17,005 23

All of which is respectfully submitted,

C. W. YOUNG,
Treasurer.

LIST OF ENTRIES IN THE SEVERAL DEPARTMENTS WITH AMOUNTS OFFERED AND AWARDED.

Department.	No. entries.	Am't offered.	Am't awarded
Cattle	833	$4,824 00	$3,587 00
Horses	273	2,859 00	1,449 00
Sheep	1,472	3,166 00	3,063 00
Swine	734	2,466 00	1,783 00
Poultry, open to all	889	654 00	485 00
Poultry, Michigan	641	677 00	372 00
Farm and Garden Products:			
Grains	215	261 00	202 00
Roots and vegetables	421	233 00	215 00
County exhibits	6	300 00	200 00
Dairy and Domestic:			
Butter and cheese	93	300 00	299 55
Sugar and bread	83	57 50	42 50
Bees and honey	42	133 00	123 00
Art:			
Professionals	184	565 00	338 00
Amateur	188	247 00	206 00
Industrial	15	84 00	57 00

Needle and Fancy Work:			
Professional	100	$322 50	$107 75
Amateur	591	319 50	151 50
Horticultural:			
Special county exhibits	5	500 00	360 00
Collections	36	439 00	190 00
Single plates	684	316 50	235 50
Dried, canned and preserved	264	165 00	173 00
Potted plants, professional	10	191 00	90 00
Cut flowers, professional	15	109 50	80 00
Potted plants, amateur	4	29 75	5 00
Cut flowers, amateur	42	45 00	39 00
Non-enumerated	64		36 50
School Work:			
High school	62	89 00	25 00
Grammar	150	130 00	123 00
Primary and kindergarten	141	121 50	102 50
Manual training	28	75 00	28 00
Village and district schools	23	104 00	47 00

Executive Committee—Winter Meeting.

Date, 1904.		No. of voucher.	Name.	Amount.	
Jan.	15	1	E. N. Ball, personal expense	$6 21	
		2	H. R. Dewey, personal expense	5 14	
		3	J. E. Rice, personal expense	9 89	
		4	W. E. Boyden, personal expense	11 72	
		5	Frank Maynard, personal expense	5 97	
		6	C. A. Waldron, personal expense	5 75	
		7	G. H. German, personal expense	4 80	
		8	W. P. Custard, personal expense	12 59	
		9	M. P. Anderson, personal expense	11 14	
		10	F. E. Skeels, personal expense	13 92	
		11	B. E. Hall, personal expense	9 38	
		12	E. W. Hardy, personal expense	5 89	
		13	John Marshall, personal expense	7 46	
		14	L. W. Barnes, personal expense	5 45	
		15	M. L. Dean, personal expense	8 42	
Feb.	3	17	John A. Hoffman, personal expense	7 96	
April	30	26	W. W. Collier, personal expense	2 50	
May	6	36	John McKay, personal expense	4 85	
		38	C. W. Young, personal expense	14 81	
June	30	53	Eugene Fifield, personal expense	8 47	
					$162 32

Executive Committee—Other Meetings.

Jan.	15	10	F. E. Skeels, personal expense	$13 17
April	20	21	Frank Maynard, personal expense	14 08
		22	M. L. Dean, pesonal expense	3 00
	23	23	I. H. Butterfield, personal expense	19 84
	27	24	Stephen Baldwin, personal expense	16 50
	30	26	W. W. Collier, personal expense	16 95
		27	E. W. Hardy, personal expense	16 67
May	6	29	J. E. Rice, personal expense	24 79
		30	W. P. Custard, personal expense	28 68
		31	C. A. Waldron, personal expense	20 92
		32	E. N. Ball, personal expense	26 96
		33	G. H. German, personal expense	23 55
		34	H. R. Dewey, personal expense	23 20
		35	M. P. Anderson, personal expense	31 26
		36	John McKay, personal expense	23 41
		37	L. W. Barnes, personal expense	23 60
		38	C. W. Young, personal expense	45 18
	9	41	John Marshall, personal expense	51 60
	23	43	F. E. Skeels, personal expense	44 60

June	3	44	W. E. Boyden, personal expense	$35 02	
	30	53	Eugene Fifield, personal expense	35 81	
July	1	55	John A. Hoffman, personal expense	22 38	
	26	62	I. H. Butterfield, personal expense	4 50	
Sept.	16	104	M. P. Anderson, personal expense	9 51	
	24	132	B. E. Hall, personal expense	35 43	
	26	156	W. E. Boyden, personal expense	5 21	
Oct.	3	167	F. E. Skeels, personal expense	1 50	
	27	180	H. R. Dewey, personal expense	9 83	
		181	W. P. Custard, persoual expense	19 48	
		182	W. E. Boyden, personal expense	9 42	
		183	J. E. Rice, personal expense	18 50	
		184	L. W. Barnes, personal expense	11 95	
		185	Frank Maynard, personal expense	4 04	
		186	Byron E. Hall, personal expense	8 51	
		187	C. A. Waldron, personal expense	6 50	
		188	E. N. Ball, personal expense	9 70	
		189	M. P. Anderson, personal expense	17 41	
		190	H. H. Hinds, personal expense	33 20	
Nov.	2	194	John Marshall, personal expense	14 94	
					$780 60

Business Committee.

Feb.	3	17	John A. Hoffman, blanace salary 1903	$70 00	
April	23	23	I. H. Butterfield, expenses	4 50	
June	30	53	Eugene Fifield, expenses	16 68	
July	1	55	John A. Hoffman, expenses	14 90	
	26	62	I. H. Butterfield, expenses	7 71	
Aug.	31	80	I. H. Butterfield, expenses	90	
Sept.	24	129	Eugene Fifield, chairman, salary and expenses	320 43	
		134	Eugene Fifield, expenses	45 71	
	26	157	John A. Hoffman, expenses and salary	145 72	
					626 55

Locating Committee.

Mar.	1	20	I. H. Butterfield, expenses	$1 10	
April	23	23	I. H. Butterfield, expenses	5 05	
April	30	26	W. W. Collier, expenses	5 80	
May	6	38	C. W. Young, expenses	44 31	
June	3	53	Eugene Fifield, expenses	21 28	
July	1	55	John A. Hoffman, expenses	23 82	
					101 36

Finance Committee.

Sept.	16	104	M. P. Anderson, expenses and salary	$50 96	
Sept.	24	146	John McKay, expenses salary and clerk	57 45	
					107 31

President's Office.

Sept.	17	110	M. B. Armstrong, button booth	$21 00	
Sept.	24	130	J. W. Cochrane, clerk	30 73	
Sept.	24	131	Chas. A. Fisher, button booth	17 50	
		163	E. Howland, president's salary	100 00	
					169 23

Treasurer's Office.

May	6	38	C. W. Young, expenses, 1903	$9 80	
Dec.		202	C. W. Young, treasurer's salary and help	591 00	
					600 80

Secretary's Office.

Mar.	1	20	I. H. Butterfield, paid stenographer weekly meeting	$7 50	
May	1	28	I. H. Butterfield, part salary	100 00	

June	6	45	I. H. Butterfield, part salary	$100 00	
June	3	52	I. H. Butterfield, part salary	200 00	
July	26	62	I. H. Butterfield, paid typewriting	2 50	
Aug.	1	67	I. H. Butterfield, part salary	100 00	
Sept.	17	108	F. A. Orvis, clerk	23 75	
Sept.	21	126	I. H. Butterfield, paid clerk (Press)	15 00	
Sept.	24	143	I. H. Butterfield, secretary's pay roll, office	147 25	
Sept.	26	155	Hugh Nelson, clerk	30 36	
Oct.	27	176	Chas. A. Smith, clerk	116 00	
Nov.	1	197	I. H. Butterfield, part salary	500 00	
1905.					
Jan.	9	209	I. H. Butterfield, part salary	100 00	
					$1,442 36

Speed Department.

Mar.	18	18	I. H. Butterfield, Michigan T. & P. Circuit	$15 00	
Aug.	2	66	American Trotting Association, membership dues	50 00	
Sept.	13	91	Eugene Fifield, superintendent purses	1,000 00	
Sept.	16	92	Eugene Fifield, superintendent purses	3,000 00	
Sept.	16	102	J. T. Rundel, assistant superintendent	33 95	
Sept.	17	106	Geo. S. Ward, assistant and expenses	159 53	
Sept.	17	110	M. B. Armstrong, getting entries	7 75	
Sept.	16	121	Eugene Fifield, to pay purses	1,000 00	
Sept.	24	122	Eugene Fifield, judge and help	95 28	
Sept.	21	125	I. H. Butterfield, sec., paid advertising bills	47 25	
Sept.	21	126	I. H. Butterfield, paid printing badges	9 00	
Sept.	26	128	F. E. Skeels, paid team work on track	14 50	
Sept.	24	129	Eugene Fifield, superintendent, paid judge	16 50	
Sept.	24	135	Eugene Fifield, paid John Carmody	50 00	
Sept.	24	144	Pontiac Pub. Co., printing race cards and list	13 50	
Oct.	1	161	F. E. Skeels, paid work on track	27 75	
Oct.	27	175	The Western Horseman, advertising races	15 00	
Oct.	26	195	I. H. Butterfield, secretary, horse hire and advertising paid	22 00	
					5,576 98

Horse Department.

Sept.	24	133	C. A. Waldron, superintendent, expenses, salary and judge	$82 63	
					82 63

Cattle Department.

Sept.	16	93	W. R. Montgomery, judge	$18 13	
		94	W. F. Potts, judge	32 50	
	26	152	W. E. Boyden, supt., expenses and salary	82 18	
		156	W. E. Boyden, paid assistant	12 00	
					144 81

Sheep Department.

Sept.	16	94	W. F. Potts, judge	$32 50	
	26	149	H. R. Dewey, supt., expenses and salary	54 79	
Oct.	4	162	C. C. Dorr, judge	18 25	
					105 54

Swine Department.

Sept.	16	118	L. W. Dehwart, judge	$30 00	
	26	151	L. W. Barnes, supt., expenses and salary	55 00	
					85 00

Poultry Department.

Sept.	16	117	Daniel Thomas, assistant supt., and expenses	$35 35	
	21	124	I. H. Butterfield, sec., paid judge and clerk	35 50	
					70 85

Farm and Garden Department.

Sept.	26	147	E. W. Hardy, supt., expenses and salary, and judge	$69 33	$69 33

Dairy Department.

Sept.	17	110	M. B. Armstrong, assistant superintendent...	$3 00	
	24	153	John Marshall, supt., expenses and salary and judge	85 49	
					88 49

Vehicle Department.

Sept.	16	95	J. E. Rice, supt., expenses and salary.........	$88 39	88 39

Farm Implement Department.

Sept.	26	157	John A. Hoffman, supt., expenses............	36 61	36 61

Manufacturers and Main Building.

Oct.	1	161	F. E. Skeels, supt., paid help.................	18 00	
	3	167	F. E. Skeels, supt., salary...................	30 00	
					48 00

Art Department.

Sept.	24	132	B. E. Hall, supt., expenses and judge.........	$78 30	78 30

Needlework Department.

Sept.	26	128	F. E. Skeels, supt., help paid................	32 25	
Oct.	1	161	F. E. Skeels, supt., help paid................	12 00	
	3	167	F. E. Skeels, supt.	4 20	
					48 45

Horticultural Department.

Sept.	17	112	M. L. Dean, supt., supt. expenses help.........	$91 50	
	21	123	I. H. Butterfield, sec., wood plates............	5 00	
		124	I. H. Butterfield, sec., paid judge and help....	23 15	
	21	126	I. H. Butterfield, sec., cold storage...........	12 20	
Oct.	26	195	I. H. Butterfield, sec., glassware..............	6 20	
Nov.	28	200	M. L. Dean, supt., balance salary unpaid......	15 00	
					153 05

School Department.

Sept.	26	150	Frank Maynard, supt., expenses and salary...	$67 21	67 21

Gates Department.

Sept.	16	96	W. P. Custard, supt., pay roll...............	258 94	
	26	154	W. P. Custard, supt., expenses and salary....	58 41	
					317 35

Police Department.

Sept.	16	97	E. N. Ball, supt., pay roll....................	$730 00	
	17	107	E. N. Ball, supt., expenses and salary........	55 02	
		112	Chas. P. Seider Tent Co., cots................	8 75	
		129	Eugene Fifield, paid police...................	5 00	
					798 77

Forage.

Sept.	26	148	G. H. German, supt., expenses and salary.....	$39 15	
		145	O. M. Carpenter, straw........................	328 00	
					367 15

Postage.

Feb.	3	17	John A. Hoffman, postage	$2 00	
Mar.	1	20	I. H. Butterfield, stamps	10 00	
April	23	23	I. H. Butterfield, stamps	6 00	
May	9	39	H. A. Wyckoff, P. M., stamps	20 00	
June	11	46	H. A. Wyckoff, P. M., stamps	20 00	
July	1	55	John A. Hoffman, postage	6 00	
	26	62	I. H. Butterfield, stamps	7 24	
Aug.	2	64	H. A. Wyckoff, P. M., stamps	100 00	
	11	72	H. A. Wyckoff, P. M., stamps	40 00	
Sept.	20	119	I. H. Butterfield, stamps and envelopes	15 50	
	26	157	John A. Hoffman, postage paid	10 00	
Oct.	3	167	F. E. Skeels, postage paid	4 00	
	25	177	I. H. Butterfield, postage paid	48 00	
	26	192	E. Howland & Sons, postage paid	12 08	
Jan.	9	209	I. H. Butterfield, sec, postage	11 10	
					$300 82

Advertising.

Mar.	1	19	Barnes-Crosby Co., halftones	$45 14	
June	22	51	The Benjamin Printing Co., post cards	15 50	
July	2	58	The Peninsular Engraving Co., halftones	10 86	
	19	60	The Commercial Ptg. Co., blotters and fans	89 00	
	22	65	Brown & Bigelow, horse covers	112 50	
Aug.	1	68	Jos. Mack Ptg. House, hangers	82 69	
	31	80	I. H. Butterfield, sec., paid help	9 80	
July	22	81	Barnes-Crosby Co., halftones	26 66	
Sept.	8	83	Modern Mfg. Co, horse covers	46 00	
	1	85	Morrison Ptg. Co., banners and half sheets	60 00	
		86	Stephen Middleton, distributing advertising	38 30	
		87	C. W. Young, treasurer, sundry bills paid	61 05	
	6	88	Chas. D. Cowles, dristributing advertising	23 25	
		89	The Commercial Ptg. Co., hangers	9 50	
	17	107	E. N. Ball, distributing advertising	5 00	
		108	F. A. Orvis, distributing advertising	17 50	
		112	Chas. P. Seider Co., banners	28 65	
		119	I. H. Butterfield, sec, bills paid	77 65	
	16	120	F. B. Howlet, posting and distributing	30 70	
	24	122	Eugene Fifield, paid posting and distributing	19 00	
	21	123	I. H. Butterfield, sec., paid bills	117 15	
		124	I. H. Butterfield, sec., paid bills	14 50	
		125	I. H. Butterfield, sec., paid bills	130 81	
		126	I. H. Butterfield, sec., paid bills	99 73	
	24	136	Pontiac Gazette, advertising	57 00	
		137	The Gleaner, advertising	50 00	
		138	The Evening News Association, advertising	231 84	
		139	The Angelus Pub Co., advertising	25 00	
		141	Brownell & Humphrey, adv. in list papers	321 39	
		142	The Abend Post, advertising	30 00	
		144	Pontiac Pub. Co., fair bulletin and adv	273 15	
		146	John McKay, paid distributing	4 00	
		154	W. P. Custard, paid advertising	1 10	
		155	Hugh Nelson, distributing advertising	29 47	
	28	159	The Detroit Free Press, advertising	157 87	
Oct.	6	166	The Detroit Journal, advertising	110 00	
	7	168	The Michigan Farmer, advertising	90 72	
	15	172	Detroit Today Co., advertising	53 20	
	25	177	I. H. Butterfield, sec., advertising paid	12 63	
	26	178	I. H. Butterfield, sec., bills paid	45 37	
		195	I H. Butterfield, sec., bills paid	44 00	
	27	196	Evening News Association, advertising races	10 00	
Dec.	31	205	Brownell & Humphrey, electros and postage	54 41	
					2,772 09

Attractions.

Sept.	16	98	Chas. E. Rice, ponies and dog	$300 00	
		99	H. C. Devlin, military drill	300 00	
		100	A. M. Schreyer, high dive	625 00	
		105	G. H. Turk, expenses fire teams	170 00	
	21	124	I. H. Butterfield, sec., freight paid	56 70	
	24	135	Eugene Fifield, fare firemen	10 92	
Oct.	26	178	I. H. Butterfield, sec, paid C. D. B. asst	15 00	
					$1,477 62

Music.

Sept.	16	101	C. A. Bingham, band	$154 00	154 00

Ribbons and Badges.

Sept.	17	115	Fair Ticket & Supply Co., premium cards	6 63	
	22	140	Armstrong Regalia Co., premium ribbons	126 00	
	29	160	Waite Bros. & Robinson, buttons	13 48	
Nov.	3	198	Calvert Lithograph Co., diplomas	25 00	
Sept.	8	90	Somner Badge Co., poultry ribbons	61 75	
	21	123	I. H. Butterfield, officers' badges	16 16	
					249 02

Premium List.

June	24	49	F. E. Skeels, soliciting advertising	$142 74	
July	9	57	F. E. Skeels, soliciting advertising	124 00	
	28	61	Barnes-Crosby Co., drawing and halftones for cover	242 00	
Aug.	3	75	Printing premium lists as per contract	3,780 00	
					4,288 74

Printing and Stationery.

Mar.	1	19	Barnes-Crosby Co., cuts for stationery, etc.	$16 40	
	1	20	I. H. Butterfield, photograph seal, etc	5 63	
April	23	23	I. H. Butterfield, paper	35	
June	30	54	Commercial Ptg. Co., stationery	87 00	
July	19	60	Commercial Ptg. Co., circular letters	2 75	
	28	61	Barnes-Crosby Co., envelopes, drawing and cut	23 64	
	26	62	I. H. Butterfield, sundries	1 40	
Aug.	31	80	I. H. Butterfield	1 40	
Sept.	6	89	Commercial Ptg. Co., envelopes	4 25	
	17	115	Fair Ticket & Supply Co., tickets	47 50	
		116	C. & J. Gregory, comp. and special tickets	26 00	
	20	119	I. H. Butterfield, sec., bills paid	5 80	
	21	124	I. H. Butterfield, sec., bills paid	15 50	
	24	136	Pontiac Gazette, printing	94 50	
		144	Pontiac Pub. Co., printing	45 25	
	26	157	John A. Hoffman, paid	1 85	
Oct.	15	171	Joseph Mack Ptg. House, printing	6 10	
	25	177	I. H. Butterfield, printing paid	1 50	
	26	178	I. H. Butterfield, sec., bills paid	18 57	
		195	I. H. Butterfield, bills paid	10 75	
Jan.	9	209	I. H. Butterfield, bills paid	7 70	
					423 84

General Expense.

Aug.	10	70	C. M. Crofoot, rent office	$15 00	
Sept.	16	103	C. Harry Hinds, services	13 23	
	17	109	Modern Mfg. Co., banners	26 60	
		114	Bay City Hardware Co., punches	19 00	
	26	128	F. E. Skeels, labor paid	16 50	
		158	C. E. Walter, photographs	32 50	
Oct.	5	165	Michigan Fish Commission exhibit	218 22	
	25	178	I. H. Butterfield, sec., bills paid	25 00	

Dec.	1	201	Mrs. E. A. Crofoot, rent office	$15 00	
Jan.	9	209	I. H. Butterfield, expenses	14 05	
	9	210	John A. Hoffman, expenses	73 76	
Dec.	24	206	S. N. Dulctur, U. P. exhibit	200 00	
					$668 86

Buildings and Grounds.

Jan.	15	16	O. M. Carpenter, tile (1903)	$29 53	
May	19	42	Oakland County Agricultural Society, rent	1,000 00	
June	25	50	Chas. Durkee, cinders on grounds	36 50	
July	25	59	F. E. Skeels, pay roll, labor	178 73	
Aug.	6	69	F. E. Skeels, pay roll, labor	116 00	
	10	73	John Bell & Son, lumber	9 70	
	11	74	F. E. Skeels, services and expenses	124 00	
	18	76	F. E. Skeels, pay roll	253 23	
	30	78	F. E. Skeels, services and expenses	124 00	
		79	F. E. Skeels, pay roll, labor	239 38	
	17	82	Howland Mfg. Co., stakes	7 50	
	22	84	D. J. Oliver, laundry cotton	8 40	
Sept.	17	93A	Modern Mfg. Co., decorations	200 00	
		111	F. E. Skeels, pay roll, labor	308 04	
		112	Chas. P. Seider Tent Co., rent tents	120 00	
	20	119	I. H. Butterfield, bills paid	34 69	
	26	127	E. J. Hallett, hardware, nails, etc	68 40	
		128	F. E. Skeels, pay roll, labor	180 00	
	28	160	Waite Bros. & Robertson, cloth, etc	162 99	
Oct.	1	161	F. E. Skeels, pay roll, labor	182 86	
	3	167	F. E. Skeels, services	133 00	
	10	170	A. A. Corwin, lumber	265 24	
	20	173	Oakland County Agricultural Society, rent paid	130 00	
	27	174	The Onyx Paint Co., paint	29 27	
	26	178	I. H. Butterfield, sec., shop work	4 25	
	27	191	Modern Mfg. Co., rent tents	84 50	
	26	192	E. Howland & Sons, fence and staples	14 32	
	10	193	F. E. Skeels, cleaning up grounds	55 88	
Oct.	26	195	I. H. Butterfield, sec., janitor paid	12 00	
Dec.	1	206	F. E. Skeels, work on grounds	120 00	
					4,231 91

Telegraph and Telephone.

Feb.	3	17	John A. Hoffman	$1 60	
Mar.	1	20	I. H. Butterfield, bill paid	4 67	
April	23	23	I. H. Butterfield, bill paid	2 55	
June	30	53	Eugene Fifield, bill paid	7 68	
July	1	55	John A. Hoffman, bill paid	6 65	
	26	62	I. H. Butterfield, bill paid	2 85	
Sept.	26	157	John A. Hoffman, bill paid	5 50	
Oct.	10	169	Michigan Telephone Co., rent and service	33 06	
	25	177	I. H. Butterfield, sec, paid telegraph	2 09	
	26	178	I. H. Butterfield, sec., paid telegraph	4 69	
Jan.	9	209	I. H. Butterfield, sec., paid telegraph	4 70	
					76 04

Freight and Express.

Mar.	1	20	I. H. Butterfield, American Express, paid	$4 90
April	23	23	I. H. Butterfield, freight paid	1 05
May	6	36	John McKay, express paid	70
July	1	56	American Express Co., express paid	7 03
	26	62	I. H. Butterfield, freight paid	2 53
Aug.	23	77	American Express, express paid	25 13
	31	80	I. H. Butterfield, express and freight paid	15 73
Sept.	8	83	Modern Mfg. Co., express on horse covers	2 30
	20	119	I. H. Butterfield, freight paid	2 76

Oct.	4	164	American Express Co., express paid...........	$28 30	
	15	171	Jos. Mack Ptg. House, freight on premium lists	95 02	
	25	177	I. H. Butterfield, freight paid................	8 96	
Jan.	9	209	I. H. Butterfield, freight paid................	2 25	
					$196 64

Sundry Expenses.

Jan.	15	11	B. E. Hall, Maccabee admissions rebate......	$12 00	
April	30	25	Grand Rapids Insurance Agency, bond of sec..	7 50	
May	19	40	Detroit Free Press, advertising, 1903.........	13 25	
June	7	47	F. L. Elliott, chair and case.................	12 50	
	15	48	C. L. Collins, attorney fee...................	50 00	
July	26	62	I. H. Butterfield, sundries....................	3 14	
	28	63	John Bell & Sons, lumber, 1903...............	6 25	
Aug.	11	71	W. H. Newton, fence panels, 1903............	8 00	
	31	80	I. H. Butterfield	4 30	
Sept.	20	119	I. H. Butterfield, sundry items...............	12 25	
	24	122	Eugene Fifield, grand stand..................	6 00	
	21	124	I. H. Butterfield, sec., bills paid.............	6 00	
	26	127	E. J. Hallett, hammer and tacks.............	1 28	
	24	135	Eugene Fifield, paid judge election...........	8 93	
Oct.	25	177	I. H. Butterfield, sec., sundries paid..........	9 18	
	26	178	I. H. Butterfield, sec., sundries paid..........	21 30	
		195	I. H. Butterfield, sec., sundries paid..........	2 50	
Jan.	9	209	I. H. Butterfield, sec., sundries paid..........	8 62	
					193 00

New Grounds and Equipment.

Oct.	27	179	Roy S. Barnhart, treas., Michigan Building...	$1,250 00	
Nov.	28	199	Chas. H. Vick, plates, Horticultural Dept.....	100 00	
Dec.	1	207	F. E. Skeels, work on new grounds...........	109 00	
		203	C. W. Young, treas., expense visiting committee	413 42	
					1,872 42

SUMMARY.

Executive Committee, winter meeting	$162 32
Executive Committee, special meetings	780 60
Business Committee	626 55
Locating Committee	101 36
Finance Committee	107 31
Treasurer's Office	600 80
President's Office	169 23
Secretary's Office	1,542 36
Speed Department	5,576 98
Horse Department	82 63
Cattle Department	144 81
Sheep Department	105 54
Swine Department	85 00
Poultry Department	70 85
Farm and Garden Department	69 33
Dairy Department	88 49
Vehicle Department	88 39
Farm Implement Department	36 61
Manufacturers and Main Building	48 00
Art Department	78 30
Needlework Department	48 45
Horticultural Department	153 05
School Department	67 21
Gates Department	317 35
Police Department	798 77
Forage Department	367 15
Postage	300 82
Advertising	2,772 09
Attractions	1,477 62
Music	154 00
Ribbons and Badges	249 02
Printing and stationery	423 84
General expense	668 86
Telegraph and Telephone	76 04
Buildings and grounds	4,231 91
Freight and express	196 64
Sundry expense	193 00
Premiums	14,660 09
New grounds and equipment	1,872 42
Premium list	4,288 74
	$43,882 53

MICHIGAN STATE GRANGE AND FARMERS' CLUBS.

REPORT OF MICHIGAN STATE GRANGE FOR THE YEAR ENDING JUNE 30, 1905.

OFFICERS OF MICHIGAN STATE GRANGE FOR 1904-1905.

Master—G. B. Horton, Fruit Ridge.
Overseer—N. P. Hull, Dimondale.
Lecturer—Mrs. F. D. Saunders, Rockford.
Steward—T. E. Niles, Mancelona.
Assistant Steward—Oscar Inman, Averill.
Chaplain—Mrs. O. J. C. Woodman, Paw Paw.
Treasurer—E. A. Strong, Vicksburg.
Secretary—Miss Jennie Buell, Ann Arbor.
Gatekeeper—G. A. Whitbeck, Montague.
Ceres—Mrs. Emma J. Gehlbach, Fremont.
Flora—Mrs. Virginia Halladay, Clinton.
Pomona—Mrs. Ida Haybarker, Leroy.
Lady Assistant Steward—Mrs. Sarah Inman, Averill.

EXECUTIVE COMMITTEE.

F. W. Redfern, Maple Rapids	December,	1905
E. A. Holden, Lansing	"	1905
Emory E. Owen, Lapeer	"	1905
C. S. Bartlett, Pontiac	"	1906
A. E. Palmer, Kalkaska	"	1906
B. E. Kies, Hillsdale	"	1906
T. H. McNaughton, Ada	"	1906

G. B. Horton, Fruit Ridge; Jennie Buell, Ann Arbor, ex-Officio.

The progress of the year is thus set forth by State Master G. B. Horton in his address before the Thirty-second Annual Session of State Grange, held in Lansing, December 13-16, 1904:

"Since last we met there has been general activity all along the line. Each separate feature of work has received careful attention and results should in a general way be gratifying to our entire membership. Eighty Granges have been added to our list and our membership has been increased to the point where if all who are retained on the books of local Granges are counted, a full 50,000 aggregate may be reported. Our treasury is in a substantial condition with invested funds intact, and with current receipts and expenditures, leaving a safe balance on the credit side."

The year ending June 30, 1905, finds 750 subordinate Granges in the State, 53 of which have been organized within the year. In addition, five county and eight juvenile Granges have been established. The continued accession of new and untrained membership has placed upon State Grange a duty both important and difficult to fulfill. Thousands of men and women, for the most part unused to working together, are here

to be schooled and led in organized efforts for the betterment of themselves and their surroundings. That the need of keeping this great undertaking in touch with the newer life now throbbing through the veins of agriculture is fully realized, will be seen from the following paragraphs from the State Lecturer's report:

"If agriculture study is to have a place in our public schools, is it less fitting that the mass of farmers who are performing the agriculture work of today, be furnished the opportunity of getting instruction in the scientific principles underlying their profession? In other words, should it not have a place in our Grange school?

"The number of observers and workers for the government in agricultural lines are being increased every year and the results given freely to the public. The farmer is the one who should be most vitally interested and enthusiastic from a standpoint of curiosity, as he is the one most vitally affected in the outcome in the commercial enterprises set on foot by the results thus secured.

"This the farmer should be, but is he? We are sometimes led to think that other classes are appreciating the 'new agriculture' more than the farmers. A beginning has been made in the study of agriculture through Grange programs and home reading; only a beginning, it is true, but along with that a foundation is being laid for an increase to the new line of educational work. And that it is in just the stage where it needs the most intelligent and careful treatment we are fully conscious.

"The beginning was made from text book study. This year we sought the co-operation of the college; it was freely given and each issue of our bulletin has been accompanied by a special bulletin upon agricultural topics of which has been prepared at the college.

"There is no question but what these special bulletins have materially aided this extension work, the regret is that more copies of each issue could not be obtained to put in circulation.

"No more important question considering the imperative need of the times will come before this meeting than of devising ways and means of continuing this Grange extension work in agriculture.

"Shall the large membership in our order show a lethargy and indifference to that which pertains to their own welfare? National Master Jones says: 'The farmers of today and the future must be students, and the Grange is the school, the medium for the exchange of information and methods between farmers, that all may profit by the knowledge gained by each. And that no great order, any more than an individual or a nation, can continue to prosper and etxend its influence unless it continues to grow and grapple with the problems that continually appear in this age of wonderful progress.'

"Our order does not rest upon its past record, but continues to keep abreast of the ever changing conditions to uphold the interest of agriculture."

In order to meet the increasing demands for some system in disposing of farm produce, the Department of Grange Information, organized early in 1904, has spent much time and thought upon ways and means to attain this coveted end. The state committee in charge of this department, reports their work of the first season as follows:

"The new feature of co-operative work may be properly divided into two departments.

"I. That of patron dealing with patron in the state and in different states.

"II. Selling profitably.

"So far our Grange co-operative efforts have been concentrated on the question of 'buying profitably.' Selling profitably is the more important question. The following illustration will show its importance: Apples were put on board cars in Hamburg, Mich., which netted the farmer twenty cents per one hundred pounds. They should have netted him forty or fifty cents a bushel. A patron from the northern part of the state said that he netted sixty-five cents per bushel for choice apples.

"Early in the year it was found that there was a scarcity of clover seed. The bureau after consulting with your acting chairman, made arrangements with a large and reliable seed firm to furnish a strictly No. 1 seed at a price ranging from fifty cents to a dollar per bushel under the prevailing market price. Unfortunately the opening of the bureau was so late in the season that many Granges had purchased their seed. However over $2,000 worth of seed was purchased under this arrangement. Nearly one hundred Granges took advantage of the opportunity, and, without a single exception, with entire satisfaction. In fact, the seed obtained was of much better quality than that being sold in our retail markets at a much higher price. Samples of seed were received from dealers in various parts of the state, taken to the college, and tested. The seed purchased through the medium of the bureau received the highest test, both as regards cleanness and germination. The germination test revealed that in most instances the seed was actually worth from one to two dollars per bushel more than the seed sold by the dealers. Hence, it is apparent that the saving to the members in buying strictly first-class seed was probably even greater than the saving of the actual difference in price.

"A little later in the season it developed that good seed corn was a scarce article. The bureau sought information from members of enrolled Granges and others, and succeeded in getting a large portion of the seed corn offered for sale tested for germination, and thus assisted many members to obtain seed that would grow, saving them the necessity of replanting. The bureau also assisted members having good seed to dispose of it at reasonable prices. Here at least is an instance of patron dealing with patron that proved valuable to both.

"Just how many cedar posts have been purchased by the various Granges, I have no means of knowing. Fifty or more carloads at a saving of from twenty to fifty dollars per car would seem to be a very conservative estimate.

"Many other satisfactory transactions have been reported."

Another recently founded department is that of Grange supervision. This is to strengthen all lines of work by the systematic visiting of local points by well drilled deputies. The results have been very satisfying and the plan is being carried on this year with special emphasis upon the lecture hour and esoteric work of the order.

In the affairs of State, the Granges have notably advocated the passage of a direct nominating law and, in national matters, the State Grange has continued to co-operate with the National Grange for the securing of:

"The adoption of a postal savings bank system.

"An amendment to the constitution providing for the election of United States Senators by direct vote of the people.

"Strengthen national pure food laws.

"Extend the privileges of the parcels post so that packages of at least twelve pounds may be carried through the mails.

"To extend the markets of farm produce equally with manufactured articles.

"Enlarge the powers and duties of the Interstate Commerce Commission.

"Amend the anti-trust law so as to clearly define what acts on the part of corporations would be clearly detrimental to public welfare.

"National aid to improve the public highways."

JENNIE BUELL,
Secretary Michigan State Grange.

MICHIGAN STATE ASSOCIATION OF FARMERS' CLUBS.

Report of the Michigan State Association of Farmers' Clubs for the year ending December 14, 1904.

OFFICERS FOR 1905.

President—Charles B. Cook, Owosso.
Vice President—Mrs. Jennie Ford, Jackson.
Secretary—Mrs. George Auten, Clyde.
Treasurer—Miss Myra Wood, Mason.

DIRECTORS.

Z. W. Carter, Lake Odessa.
James B. King, Marshall.
Rev. J. B. Reynolds, Romeo.
A. L. Chandler, Corunna.
E. H. Richey, Vassar.
L. D. Lovewell, South Lyon.

During the year the organization of farmers' clubs has been steadily increasing. We are standing today upon a firmer foundation than ever before; farmers in our rural communities are becoming thoroughly interested in this work and are beginning to realize the benefits derived from this organization.

At our executive meeting my plan for conducting and systematizing this work was heartily approved of by the executive committee and the following by-law was passed:

Resolved, That during the month of November of each year, the secretary of each local club shall report immediately after receiving a report blank to the secretary of the state association, all such information as may be necessary for said state secretary to keep a short history of each club. Such report to be made upon blanks furnished by said state association.

I am proud to say that this plan worked excellent and we have today a systematized method of work.

The following is a correct report as far as these reports have been returned to me, up to date:

Clubs on the revised membership roll, 143; 24 of this number were not on the old list and five have been newly organized to date.

The association has representatives in 34 counties with a membership of 6,324, an increase of 690 during the year; 923 club meetings were held with an average attendance of 50; 61 of these hold an annual picnic; 74 clubs are using monthly programs; 17 use yearly ones; 86 elect officers annually, 5 semi-annually; 66 clubs discuss the associational question at their regular meetings.

The death of 61 members were reported from the clubs.

I mailed during the year 689 letters, 279 circulars, 196 yearly report blanks, 242 programs, 38 constitution and by-laws of the State association, and 78 local club by-laws.

I do not wish to be understood that this is a report of all local clubs in the State, for it is not, but it is a correct report of the clubs who returned the yearly report blanks to me in time for my annual report.

Let our watchword be "Onward, ever Onward," and let us carry out the golden rule, "Do unto others as we would they should do unto us."

Believing that the greatest good is to the greatest number.

MRS. GEO. H. AUTEN, Secretary.

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